Reconnaissance Study of Uranium Deposits in the Red Desert Sweetwater County Wyoming

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GEOLOGICAL SURVEY BULLETIN 1030-I

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Reconnaissance Study of Uranium Deposits in the Red Desert Sweetwater County Wyoming

By DONALD G. WYANT, WILLIAM N. SHARP, *and* DOUGLAS M. SHERIDAN

CONTRIBUTIONS TO THE GEOLOGY OF URANIUM

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RECONNAISSANCE STUDY OF URANIUM DEPOSITS IN THE RED DESERT, SWEETWATER COUNTY, WYOMING

By DONALD G. WYANT, WILLIAM N. SHARP, and DOUGLAS M. SHERIDAN

ABSTRACT

The largest known deposit of schroeckingerite, a secondary uranium mineral, and uraniferous lignite occur in part of the Red Desert, north of Wamsutter, in northeastern Sweetwater County, Wyoming. Schroeckingerite was discovered on Lost Creek, 38 miles north of Wamsutter in 1936, and lignite between Lost Creek and Wamsutter was found to be uraniferous in 1945. It may be possible to produce uranium from the schroeckingerite deposit economically, but the outlook for commercial exploitation of the uraniferous lignite is at present uncertain.

An area of 650 square miles in the Red Desert of the Great Divide Basin was studied in reconnaissance in 1949 by a combination of photogeologic and field methods, and radioactivity was measured on the ground and from the air. Part of the area known to be underlain by uraniferous lignite was mapped in detail, and columnar sections were measured to determine, approximately, the stratigraphic relation of uraniferous lignite in the southern part of the area to the schroeckingerite-bearing beds in the Lost Creek deposit. The deposit was mapped in detail and in 1950 was tested by auger drilling.

The surface rocks in the Red Desert are intertonguing beds of sandstone, claystone, lignite, oil shale, and arkose of the Wasatch, Green River, and Bridger formations and the Continental Peak formation of Nace (1939), all of Eocene age, and shale, derived from volcanic ash, of the Chadron formation of Oligocene(?) age as defined by Nace (1939). Several units of the Green River formation are the only Eocene rocks whose formation may be identified readily. The Tertiary rocks are covered in part by Pleistocene lake and stream terrace deposits. Most of the rocks in the Red Desert are abnormally radioactive.

The topographic feature, Great Divide Basin, is a structural bowl with a few subsidiary, broad, gentle folds. In the northern part of the basin the Cyclone Rim fault zone trends northwestward and separates nearly horizontal beds to the south from folded beds to the north; stratigraphic displacement of beds is 400 to 700 feet downward on the southwestern side of the fault zone.

Three main uraniferous lignite beds, each about 10 feet thick and separated by 45–80 feet of sandstone and claystone, crop out in the southern part of the Red Desert. A fourth bed, postulated from drill cuttings, probably underlies the three main beds. Unweathered lignite is glossy black, and thin bedded. The uranium content of the lignite beds ranges from 0.002 to 0.007 percent. The average ash content of the lignite is about 38 percent and the ash contains from

0.004 to 0.022 percent uranium. The uranium in all lignite outcrops is not in radioactive equilibrium, probably because some of the uranium originally present has been leached from the outcrop. The time and mode of introduction of uranium in the lignite, as well as the source of uranium, remain problems. Data gathered during this investigation suggest that uranium was present in the decaying vegetal matter before it was coalified. More recent studies, in other areas, suggest that uranum in coal may be epigenetic.

The Lost Creek schroeckingerite deposit is within the Cyclone Rim fault zone north of the outcrops of uraniferous lignite. A bed of such lignite, however, probably underlies the deposit at a depth of a few hundred feet. Within the fault zone, the beds strike northwestward and dip about 20° NE. Schroeckingerite is a water-soluble, fluorescent, bright yellow-green uranium salt. Minerals, other than detrital quartz and feldspar, that are commonly associated with schroeckingerite are clay, gypsum, aragonite, opal, and efflorescent white salts. Schroeckingerite characteristically occurs in the Lost Creek deposit as round pelletal aggregates, as disseminated flakes, or as thin layers. The layers commonly coat the ground surface and the flakes are commonly in beds of sandstone. The pellets, concentrations of which constitute ore bodies, are distributed irregularly but appear to be localized most abundantly in five principal beds of finer-grained rocks, shale, claystone, or siltstone (of Eocene age); these beds are separated by as much as 100 feet of virtually nonuraniferous sandstone and arkose. Ore bodies are about 1 foot thick and extend as much as 35 feet down the dip of the beds and a maximum of more than 300 feet along the strike. The uranium content ranges from 0.013 to 0.28 percent.

Sandstone adjacent to ore-bearing shale beds, and some of the shale, are commonly stained red, maroon, or orange by iron oxides. Such iron-stained zones containing weakly radioactive fluorescent opal and other minerals, as well as nonfluorescent uranium minerals (or uraniferous clay aggregates) were found in auger cuttings from beneath the water table. Schroeckingerite, however, has been found only above the water table and to a maximum depth of 8 feet beneath the ground surface. The water underlying the deposit is slightly alkaline (pH of about 8) and contains an abnormal amount of uranium (0.01 to 46.0 parts per million).

Schroeckingerite crystallizes near the surface from ascending alkaline ground water, preferentially in moist claystone, shale, or in siltstone beds; the process differs genetically from deposition of caliche only in the quasi-stratigraphic control. The source of the uranium is not certain. It is possible that uranium, transported by ascending ground water circulating within the Cyclone Rim fault zone, and derived from uraniferous lignite, may have been deposited above the low water table prevailing at times in the Pleistocene epoch; later the rise of the water table may have caused the uranium mineral to be dissolved, transported, and recrystallized as schroeckingerite. Schroeckingerite may now be forming from migrating ground water at about the same rate that it is being dissolved and removed by surface water.

Further geologic and exploratory work on the uranium deposits in the Red Desert will be done.

INTRODUCTION

PURPOSE OF THE INVESTIGATION

Uranium-bearing sediments at Lost Creek in the Red Desert north of Wamsutter, Wyo., were first described by Larsen and Gonyer (1937). During subsequent investigations of the deposit, now termed the Lost Creek schroeckingerite deposit, A. L. Slaughter and J. M.

Nelson (unpublished report, 1946) found uranium-bearing lignite and shale. The U. S. Geological Survey made a reconnaissance study of the Red Desert area in 1949 to appraise the uranium resources of the area, and to accumulate data concerning the geology of uranium and the genesis of schroeckingerite and of uraniferous lignite, and to outline further work. It is hoped that this report will provide a framework for the reports of more detailed studies made in the area, and will stimulate additional discussion of the genesis of the deposits.

FIELD WORK AND ACKNOWLEDGMENTS

During about 6 weeks in the summer of 1949, a planetable map of the Lost Creek schroeckingerite deposit and several detailed sections were prepared; a geologic and ground radioactivity map was made of a small area to serve as a control for airborne radioactivity measurements; samples and radioactivity data were gathered from a large part of the area; nine key stratigraphic sections were measured; fossils were collected; and a general geologic reconnaissance was made. Aerial photographs were used in the field. In the office, uncontrolled planimetric base maps were made from the aerial photographs, and the geology was compiled on the maps from field notes and from office study of the photographs. From October to December 1950, preliminary auger testing was carried out at the schroeckingerite deposit by the Geological Survey, the results of which, although preliminary to more thorough testing, are incorporated in this report.

The work was done on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission. Samples were analyzed by the U. S. Geological Survey. The writers are indebted to Walter Byron, president of Uranium Inc., the lease holders; the late Mrs. Minnie McCormick, who discovered the schroeckingerite deposit; Kleber Hadsell, and Gasper Meyer, residents of the area; L. T. Hart, Carter Oil Co.; and R. L. Kretz, Bell Petroleum Co., for their courtesy and cooperation.

PREVIOUS WORK

No general account of the geology of the area described in this report has been published. The geology of some parts of the area, and of bordering areas, has been described by many workers, some of whose publications are cited in the list of references (Blackwelder, 1915; Bradley, 1926, 1928, and 1945; Dobbin and others, 1927; Fath and Moulton, 1924; Kemp and Knight, 1903; Nace, 1939; Schultz, 1909; Sears and Bradley, 1923; Smith, 1909; Westgate and Branson, 1913).

LOCATION AND PHYSIOGRAPHY

The Red Desert, in northeastern Sweetwater County, is in the central part of the Great Divide Basin, a topographic basin of interior

drainage that occupies about 4,000 square miles on the divide between the Colorado and Missouri River watersheds. The basin is bounded on the north by the Green Mountains, the Granite Mountains, and the Antelope Hills; on the east by the Rawlins Uplift; on the south by the Laney Rim and the Sierra Madre Range; and on the west by the Rock Springs uplift. The basin is on the eastern margin of the larger Green River Basin. About 650 square miles in the north-central part of the Great Divide Basin, a part of the Red Desert, was mapped during the investigation by reconnaissance methods. The Red Desert is an area of low relief where the altitude ranges between 6,000 and 6,600 feet. Its name refers to the red soil that mantles its southwestern part (Fenneman, p. 143, 1931). The principal topographic features are the low hills between Wamsutter and Chain Lakes; the broad depressions occupied by Chain Lakes and Lost Creek Dry Lake; the bluffs northwest of Lost Creek Dry Lake; and the escarpment of Cyclone Rim (pls. 1 and 2).

The climate is semiarid, and the vegetation accordingly consists largely of low-growing greasewood (*Sarcobatus* sp.), sagebrush (*Artemisia tridentata*), saltbush (*Atriplex* sp.), and some prairie grasses and herbs. The Red Desert is in the heart of Wyoming's sheep country; consequently the natural water supply, consisting of a few springs and permanent streams, has been augmented by several wells.

ACCESSIBILITY

Many trails or roads crisscross the Red Desert. The main-traveled road heads north from Wamsutter to the Sweetwater River through Crook's Gap in the Green Mountains. In places it is graded. From the Lost Creek schroeckingerite deposit fair roads lead east to Bairoil and northwest to Atlantic City. Ordinary vehicles may be used on all the roads, but they should be driven with caution in the sand-dune country near Lost Creek Dry Lake, and throughout the area after rains. The nearest supply point is Wamsutter, at the southern edge of the Red Desert, 40 miles west of Rawlins and 68 miles east of Rock Springs on U. S. Highway 30 and the Union Pacific Railroad.

GENERAL GEOLOGY

SEDIMENTARY ROCKS

The Red Desert is underlain largely by Tertiary sedimentary rocks (pl. 16). Most are Eocene rocks, of the same general type as those in the Green River Basin, which are more readily separated and are better known. In the Red Desert these rocks are predominantly fluviatile conglomerate, sandstone, siltstone, and claystone, with subordinate beds of lignite, all typical of the Wasatch and Bridger formations, and lacustrine shale, typical of the Green River formation.

Cropping out in a smaller area are younger fluviatile conglomerate and tuffaceous sandstone and claystone typical of parts of the Continental Peak formation of Nace (1939).

The Eocene rock units are all lenticular and interfinger with one another (Bradley, 1926, 1945; Nace, 1939). Figure 55 illustrates diagrammatically their relationships. Although these formations and members can be readily distinguished northwest of the Red Desert, they can be traced only with difficulty into this area, because the rocks are similar and the exposures are poor. Accordingly, and because of lack of time, the units were not mapped. Shale of Green River type, however, is so characteristic of the formation that such rock was mapped as lenses of the Green River formation. The area includes the eastern limits of several lenses of these shale-strata of the Green River formation. The gradation between Green River-type shale, and green claystone and sandstone characteristic of the Wasatch formation may be seen along the bluffs west of Lost Creek, and about 2 miles northeast of Eagles Nest (center of the mapped area on pl. 16). In the excavation for the sump at the site of the California-Wyoming Development Co. oil well (4½ miles north of Eagles nest, pl. 16), 8 feet or more of shale of the Green River formation is well exposed. Farther north, at the schroeckingerite deposit, several thin shale beds ranging in thickness from 0.2 to 5 feet are exposed in trenches.

Although formations were not delineated and stratigraphic correlations with formations outside of the area mapped in reconnaissance have not been attempted in this report, Bradley has traced from the west the Tipton tongue of the Green River formation and the overlying Cathedral Bluffs tongue of the Wasatch formation to within about 12 miles west of the exposures of the Green River shown on plate 16 north and west of Lost Creek Dry Lake (Bradley, W. H., written communication). Also, Nace (1939, p. 25) observed exposures of his Continental Peak formation within the Cyclone Rim at Lost Creek.

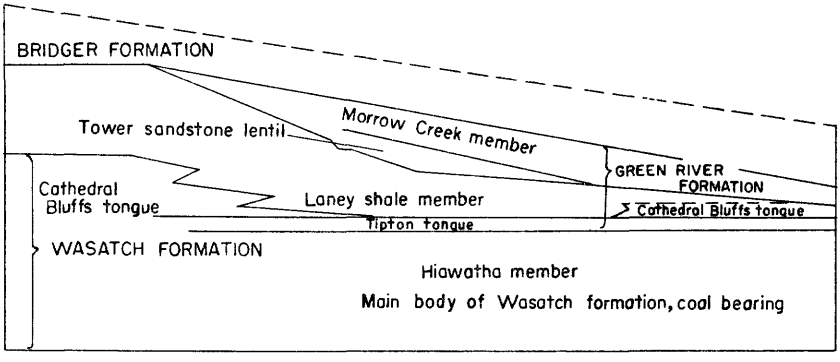

FIGURE 55.—Diagrammatic representation of accepted interpretations of relations of Wasatch, Green River, and Bridger formations (after Nace).

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Tentative geologic correlations of the Eocene rocks within the Red Desert are shown on plate 18 and are described under the heading Stratigraphic sections. As shown on plate 18, an attempt was made to correlate the beds in the vicinity of the schroeckingerite deposit, on the northeast side of the Cyclone Rim fault zone, with the lignite beds south of Chain Lakes. A detailed correlation was not possible, owing both to the distances between the measured sections and to poor exposures, but the approximate relations of the rocks throughout the area are shown.

The youngest Tertiary rocks are light-colored shale containing volcanic ash, sandstone, conglomerate, and limestone of the Chadron formation of Oligocene(?) age of Nace's usage (Nace 1939). These rocks crop out in the northwestern part of the area. They have been mapped by Nace to the west of the area shown on plate 16.[1] The Chadron formation unconformably overlies undifferentiated rocks of the Continental Peak formation of Nace (1939) and the Bridger, Green River, and Wasatch formations, all of Eocene age.

The thickness of the Tertiary section is probably about 2,000 feet. The Eocene rocks west and east of the mapped area rest conformably on the Paleocene Tongue River member of the Fort Union formation, which in turn rests unconformably on folded Cretaceous and Paleozoic rocks. North and northwest of the Red Desert the Tertiary rocks rest directly upon the Precambrian and Paleozoic "basement complex" of the Granite and Sweetwater Mountains.

Overlying the Tertiary rocks are Pleistocene and Recent fluviatile, lacustrine, eolian, colluvial, and alluvial sediments, which portray a complex physiographic history. Conspicuous features of the area are the broad depressions formerly occupied by Pleistocene lakes and, the terrace deposits bordering Recent and Pleistocene streams.

IGNEOUS ROCKS

Igneous rocks are not exposed within the Red Desert but the volcanic ash content of some beds of the Bridger, Continental Peak of Nace (1939), and Chadron formations indicate considerable volcanic activity during their deposition. The well-known lava flows and associated intrusive alkalic igneous rocks of the Leucite Hills are about 30 miles northwest of Lost Creek Dry Lake.

STRUCTURE

Structurally, most of the area is a relatively simple basin, the approximate center of which is Lost Creek Dry Lake. Broad, shallow

[1] Subsequent to the present work, more detailed mapping in the area was done, 1951–1954 by Harold Masursky and G. N. Pipiringos. Their work indicates that the Chadron formation of Nace's usage (Nace, 1939) and as shown on plate 16 may include the Brown's Park(?) formation of late Miocene or early Pliocene age. If so, the beds labeled Chadron (*Tvc*) on plate 16 may be a part of the Brown's Park, and true Chadron may either be missing, or be present in the Cyclone Rim but included in the strata mapped under the symbol *Teu* as undifferentiated formations of Tertiary age.

folds modify this simple structure; some faults displace the beds in Monument Dry Lake.

Relatively intense folding is restricted to the area north of the Cyclone Rim. The Rim marks a zone of en-echelon faulting, the Cyclone Rim fault zone, a major structural feature of the Red Desert, that extends at least 10 miles northwestward, and perhaps farther, both to the northwest and the southeast. Apparent stratigraphic displacement along the fault zone is about 400 feet downward on the southwest side and may be as much as 700 feet. The fault zone may be a high-angle thrust with movement upward on the northeast side, but more exploratory work at the schroeckingerite deposit will undoubtedly contribute more detailed information about the faulting. Some of the anticlines north of the Cyclone Rim were drilled by oil companies, but no records show production of oil or gas in the mapped area.

GEOLOGIC HISTORY

Throughout the early part of the Eocene epoch, sediments were carried into the area by streams from the surrounding lands to form the Wasatch formation. During the first stage of deposition of the formation, plant material accumulated in some swamps or bogs to form thick lignite beds. Later, intermittent fresh-water lakes were formed. The eastern margins of some were approximately along a line extending northward from Chain Lakes to a point about 2 miles east of the Lost Creek schroeckingerite deposit (pl. 16). In the lakes fine-grained sediments rich in organic matter accumulated to form the oil-rich shale and fresh-water limestone of the Green River formation that are interlayered with the fluviatile sediments of the Wasatch formation. In middle Eocene time, streams deposited grit, sand, and clay to form the Bridger formation. These fluviatile sediments were eroded, then streams deposited a sequence of tuff and tuffaceous sands, the Continental Peak formation of Nace (Nace, 1939). The strata formed by consolidation of all these sediments were tilted, faulted, eroded, and in Oligocene(?) time covered by the conglomerate, ash, and fresh-water limestone of the Chadron formation of Nace's usage (Nace, 1939). Before deposition of the Chadron, the Cyclone Rim fault zone was formed.[2] The Miocene and Pliocene epochs, although possibly represented by part of the Chadron formation as used by Nace (Nace, 1939) were probably largely epochs of erosion and nondeposition in the area of the Red Desert.

In Pleistocene time, a large amount of water flowed south from Lost Creek, past the site of Wamsutter and out of the Great Divide Basin, through a former stream channel that extends to the southwest

[2] More recent work of Masursky and Pipiringos suggests that faulting along the Cyclone Rim fault zone may have taken place before deposition of sediments of the Brown's Park(?) formation (of Miocene or Pliocene age) that are included with the Chadron formation in this report, and, possibly, after deposition of the true Chadron formation—of Oligocene age—(if missing in the area) in adjacent areas.

from the vicinity of the schroeckingerite deposit. The main channel of this Pleistocene stream is just beyond the west edge of the area shown on plate 16 and is easily recognized along U. S. Highway 30 about 7 miles west of Wamsutter. Either because of a decrease in the amount of water in late Pleistocene time, or because of local structural warping, or due to both causes, drainage out of the area ceased and large lakes were formed in the basins, whose centers are now occupied by small lakes or playas. These former lakes are called, in this report, Pleistocene Lost Lake, Pleistocene Chain Lakes (lower and upper), and Pleistocene Monument Lake. Stream terraces were cut along Lost Creek; the highest terrace above the creek probably was cut at the time of the largest expansion of Pleistocene Lost Lake.

The abrupt change in width of the terrace deposit along Lost Creek at its junction with the Cyclone Rim fault zone suggests there may have been renewed faulting in the area in late Pleistocene time, but the widening may be the result of other causes. The Pleistocene lake basins gradually are being filled with debris washed in from the surrounding highlands and from the Tertiary sediments traversed by the streams. This debris is being modified by wind action.

RADIOACTIVITY

Uraniferous sediments are widespread within the Red Desert. The average radioactivity of rocks in the area is greater than is common for sediments. As an example, sample DW–102 (S:295), (mud and silt) from the center of Lost Creek Dry Lake, contains 0.003 percent equivalent uranium[3] and 0.002 percent uranium. Evans and Goodman (1941) give for terrestrial sediments other than limestone, a uranium content of 1.3 gm per ton (0.00013 percent).

Radioactivity data were obtained with (a) hand-carried Geiger-Mueller counters and (b) an instrument composed of two 40-inch gamma-probes coupled to a car-mounted circuit, or from (c) analyses in the laboratory of the samples collected at the outcrop.

Radioactivity measured at several outcrops with both the hand-carried and the car-mounted Geiger-Mueller counters was compared with the equivalent-uranium content, determined in the laboratory, of samples taken from the same outcrops. The comparison established an approximate correlation among the different instruments used, and allowed the transformation of field radioactivity measurements to estimated percent equivalent uranium. Although the figures for estimated percent equivalent uranium plotted on the maps are not quantitatively accurate, they do indicate correctly, orders of

[3] Equivalent uranium is a measure of the total amount of radioactivity emitted by the sample, and is expressed as if all the radioactivity were due solely to uranium in equilibrium with the products in its disintegration series. The radioactivity of all radioactive substances, such as thorium, potassium (K^{40}), or uranium would, therefore, be included as the percent equivalent uranium, if they were present. The equivalent-uranium content of these samples was determined by Geiger-Mueller counters in the laboratory.

magnitude. It was not feasible during reconnaissance work to collect samples at every station. The correlation among methods used in measuring radioactivity is summarized in table 1. More than 150 observations were made in the area either with the car-mounted instrument or with the hand-carried meters. Forty-three samples were taken for analysis. Tables 3 and 4 include the laboratory analyses of materials other than lignite, carbonaceous shale, or schroeckingerite ore.

TABLE 1.—*Comparison of radioactivity measurements, Red Desert, Wyo.*

Laboratory analysis equivalent uranium (percent)	Average readings on carborne Geiger-Mueller counter (meter units)	Average readings on hand-carried counter (meter units)
0.014	15.5	17
0.013	15.0	14
0.012	14.0	11
0.010	13.0	10
0.009	12.0	9
0.008	11.0	8
0.007	10.0	7
0.006	9.0	6
0.005	9.0	5

Most of the material sampled in addition to lignite and schroeckingerite-bearing rock is abnormally radioactive but contains little uranium (tables 3 and 4). Pebbles of fluorescent chert collected from a wide area northwest of the Lost Creek schroeckingerite deposit, contain as much as 0.010 percent equivalent uranium and 0.006 percent uranium. A. L. Slaughter and J. M. Nelson (unpublished report, 1946) also collected from the general area pebbles of fluorescent chert that contain 0.030 percent equivalent uranium. They examined the Leucite Hills, 30 miles to the west of the area shown on plate 17, and reported that some of the pumice beneath one flow of leucite-rich lava contained an estimated 0.007 percent equivalent uranium.

Gypsiferous sandstone and sandy claystone collected at Arapahoe Creek contained as much as 0.006 percent equivalent uranium, and a maximum of 0.003 percent uranium.

A large quantity of the material in the immediate vicinity of the shroeckingerite deposit contains as much as 0.010 percent uranium.

On the road about 3 miles northeast of Eagles Nest the carborne Geiger-Mueller counter indicated a slight increase in radioactivity above the green claystone and red sandstone that grade laterally into shale lentils of the Green River formation.

URANIUM DEPOSITS

Most of the beds in the area mapped in the Red Desert are more than normally radioactive but contain too little uranium to be of

economic significance. The beds of radioactive lignite and the schroeckingerite-bearing sediments, which contain the most uranium, may, however, be of economic significance.

URANIFEROUS LIGNITE

In 1945, during a reconnaissance examination, A. L. Slaughter and J. M. Nelson found that some beds of lignite and carbonaceous shale in the Red Desert were abnormally radioactive. They took samples for analysis and measured one exposure of lignite (unpublished report, 1946). They observed that radioactivity was greater in the interbedded carbonaceous shales than in the adjacent lignite, and chemical analyses showed that the equivalent-uranium content was greater than the uranium content. Samples taken by them of the more radioactive lignite and shale beds contained from 0.010 to 0.015 percent equivalent uranium and from 0.002 to 0.004 percent uranium. A columnar section made by them on the west end of Sourdough Butte (see pls. 16 and 17) is given in figure 56.

DISTRIBUTION

The area examined in reconnaissance in 1949 in which radioactive lignites crop out is shown on plate 17. It extends northward from a point about 9 miles north of Wamsutter to the ridge of High Point, south of Chain Lakes—a distance of 11 miles. The maximum width of the area mapped containing radioactive lignites is about 7 miles, although the beds extend beyond the limits of this area. Thin beds of lignite are present between Wamsutter and the area studied, but they are not appreciably radioactive. They may be stratigraphically higher than the more radioactive beds.

Lignite also is exposed along U. S. Highway 30 between Rawlins and Wamsutter. Many of the exposures were examined by Slaughter and Nelson who found only one bed of appreciably radioactive clinker; their sample of this bed contained 0.012 percent equivalent uranium and 0.004 percent uranium. Smith's map (1909, pl. 12) shows about 200 square miles of the Red Desert underlain by lignite. This area extends well beyond that shown on plates 16 and 17.

Radioactive lignite also was observed (1) in the bluffs west of Lost Creek Dry Lake, (2) in cuttings from the sludge pit of a water well drilled at the site of the California-Wyoming Development Co. oil well, and (3) at Coal Bank dam about 7 miles north of the Lost Creek schroeckingerite deposit. Although the maximum extent of the radioactive lignite is unknown, such lignite probably underlies most of the area shown on plates 16 and 17, and some beds certainly extend beyond it to the east and to the west.

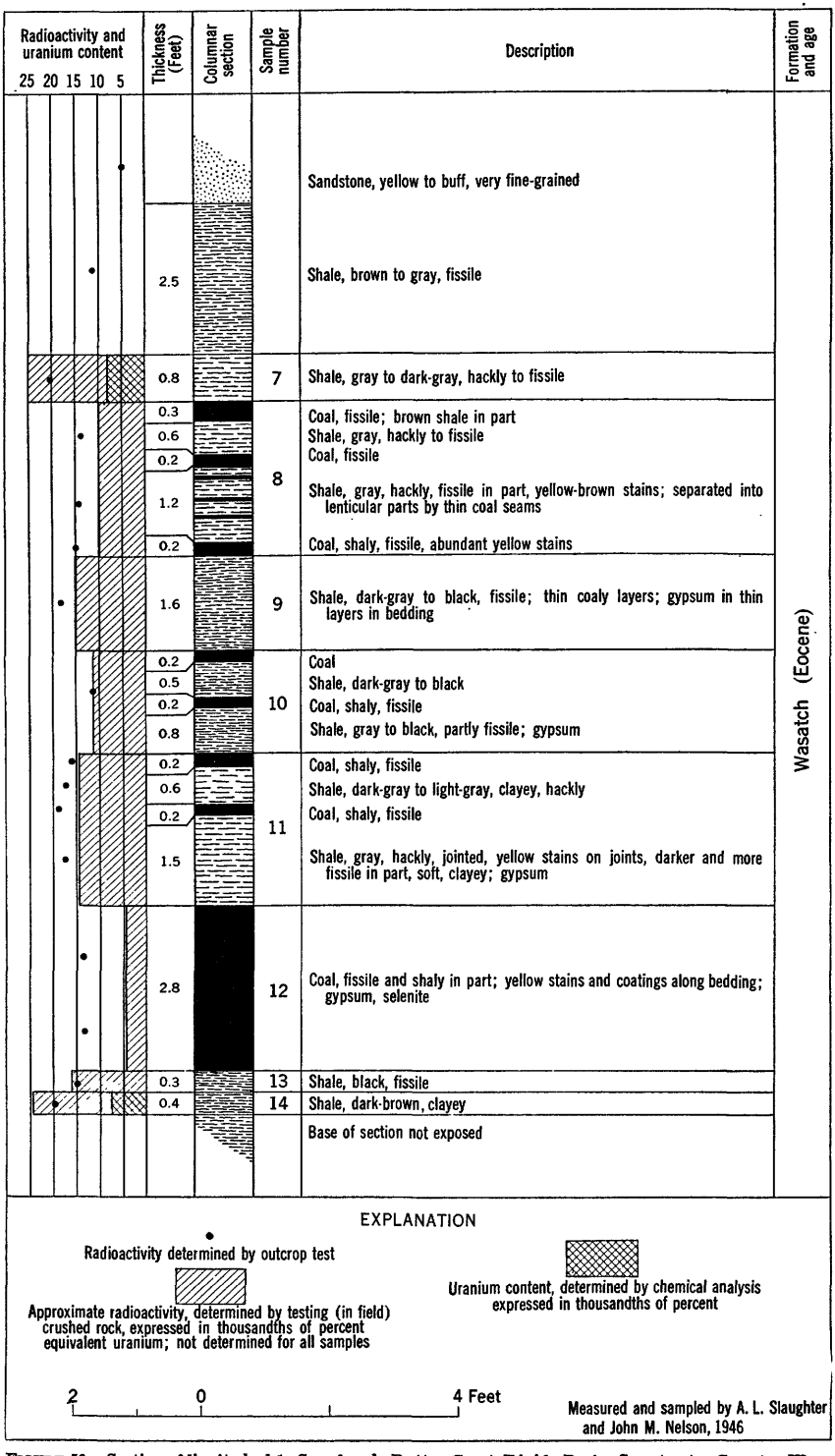

FIGURE 56.—Section of lignite bed 1, Sourdough Butte, Great Divide Basin, Sweetwater County, Wyo.

GEOLOGY

Three prominent zones containing alternating layers of lignite and carbonaceous shale have been mapped (pl. 17). These zones are designated as lignite beds in this report, and are referred to as lignite beds 1, 2, and 3, numbered in ascending stratigraphic order. Cuttings of radioactive lignite from shotholes drilled for seismic surveys indicate that another bed underlies bed 1 on the east edge of Pleistocene Monument Lake (pl. 17), but outcrops of this lower bed were not observed in the map area.

The radioactive lignite beds are probably early Eocene in age and may be correlated with part of the Wasatch formation. Plant fossils were collected from partly baked claystone underlying lignite bed 1 at the south side of Sourdough Butte. They were examined by R. W. Brown, who determined their age to be early or middle Eocene and tentatively correlated the rocks with the Eocene of Yellowstone Park. Gastropod and pelecypod fossils were collected at a point about 1¼ miles southeast of No Name well (pl. 16) from a bed of calcareous sandstone about 55 feet stratigraphically above lignite bed 3 and shown as fossilliferous zone F-9 on columnar section 5 of plate 18 (see also stratigraphic section 5, p. 280). They were examined by T. C. Yen, who determined their age as early Eocene and correlated the sandstone with a part of the Wasatch formation. Fossils of similar types were collected from other beds of calcareous sandstone about 60 feet higher stratigraphically than the bed in which zone F 9 occurs and at a point 0.8 of a mile northeast of No Name well (fossiliferous zone F-6 and F-7 on columnar section 4 of plate 18 and stratigraphic section 4, p. 279). Mr. Yen determined their age as late early Eocene and tentatively correlated these sandstone beds with the upper part of the Wasatch formation. These paleontologic data are summarized in table 2.

As shown in columnar sections 1, 2, and 3 of plate 18 and stratigraphic sections 1–3, (p. 277) the stratigraphic interval between lignite beds 1 and 2 is about 80 feet, and that between beds 2 and 3 is about 45 feet. The stratigraphic interval between bed 1 and the bed that is assumed to underly it is not definitely known, but is estimated to be about 100 feet. The total stratigraphic interval that contains the principal beds of known radioactive lignite is, therefore, about 225 feet.

The lignite beds are interbedded with gray, buff, drab, or white, micaceous arkosic sandstone, silty sandstone, and calcareous sandstone; brown, gray, or green plastic claystone; and platy carbonaceous shale. Details of lithology of the rocks are shown in the columnar sections (pl. 18 and fig. 56) and detailed descriptions are given under the heading Stratigraphic sections.

The lignite beds themselves are composed of black vitreous lignite seams from about one-sixteenth to one-half inch thick, interbedded

with dark-brown or gray fissile carbonaceous shale layers of similar thickness. The thickness of lignite beds 1 and 2 ranges from about 2.5 to 20 feet; the average in each is about 10 feet. Bed 3 ranges in thickness from about 1 to 6 feet and averages about 2 feet in thickness.

TABLE 2.—*Summary of paleontologic data, Red Desert, Wyo.*

[Identification, age, and correlation of mollusks by T. C. Yen and of plants by R. W. Brown]

Fossiliferous zone (reference no. on pls. 16 and 21)	Columnar section (pl. 18)	Fossils	Probable age	Probable correlation
F-6	4	*Viviparus paludinaeformis* (Hall).	Early Eocene	Upper part of the Wasatch formation.
F-8	4	*Unio* cf. *U. mendax* White *Viviparus paludinaeformis* (Hall). *Goniobasis tenera* (Hall) *G.* sp. undet. *Physa* cf. *P. pleuromatis* White	do	Do.
F-8	4	*Viviparus* cf. *V. paludinaeformis* (Hall). Goniobasis cf. *G. tenera* (Hall) *G.* cf. *G. arcta* (Meek) [1]	Late early Eocene.	Do.
F-9	5	*Unio* sp. undet. *Viviparus* cf. *V. paludinaeformis* (Hall). *Goniobasis* cf. *G. nodulifera* (Meek). *G.* sp. undet.	Early Eocene	Part of the Wasatch formation.
F-10	6	*Unio* cf. *U. wasatchensis* Cockerell. *U.* sp. undet. *Goniobasis* cf. *G. carterii* (Conrad).	Eocene	Upper part of the Wasatch or lower part of the Bridger formation (the collection is possibly equivalent to JBR-4 below).
F-11	7	Fragments of gastropods not identifiable.		
JBR-1	(2)	*Equisetum* sp. *Osmunda* sp. *Asplenium magnum* Knowlton *Smilax lamarensis* Knowlton Fragmentary dicotyledonous leaves. Fragmentary seeds. Beetle wings.	Early to middle Eocene.	Eocene of Yellowstone National Park.
JBR-2	7	*Pisidium* sp. undet. *Viviparus* sp. undet. (poorly preserved) *Goniobasis* sp. undet. *Menetus* sp. undet.	Possibly Eocene.	None (habitat area was probably shallow and still water).
JBR-3	9	*Goniobasis* cf. *G. nodulifera* (Meek). *G.* sp. undet. *Lymnaea* cf. *L. similis* Meek	Eocene	Upper part of the Wasatch or lower part of the Bridger formation.
JBR-4	9	*Unio* sp. undet. Goniobasis cf. *G. nodulifera* (Meek). *G.* cf. *G. arcta* (Meek)	do	Upper part of the Wasatch or lower part of the Bridger formation (the collection is possibly equivalent to F-10 above).
JBR-5	9	*Sphaerium* sp. undet. *Australorbis* cf. *A. spectabilis* (Meek). *Anisus* cf. *A. cirrus* (White) *Lymnaea* sp. undet. *Vertigo* sp. undet.	Middle Eocene.	Bridger formation.[3]
JBR-6	(4)	*Unio*, fragments of (species not determinable.)		
JBR-7	(5)	*Viviparus* sp. undet. *Australorbis* sp. undet. *Glyptperpes veternus* (Meek and Hayden). *Vespericola* sp. undet.	Eocene	Bridger formation.

[1] Goniobasis arcta (Meek) was originally described from the Bridger formation in southwest Wyoming.
[2] No columnar section measured, Sourdough Butte, lignite bed 1.
[3] This would be lower Bridger of Nace.
[4] No columnar section measured, on Lost Creek at Chalk Banks.
[5] No columnar section measured, Bridger formation of Nace, from north side of Continental Peak, Sweetwater County.

The proportion of shale to lignite varies from place to place in each lignite bed, but in general the lignite is of poor quality for use as fuel. Locally, as in bed 1 on High Point Ridge (southeast corner of the mapped area on pl. 16) and in bed 3 west of the mouth of Sourdough Creek (sample WNS–13 (S:18)), the lignite is free from clay. As noted in table 6, sample WNS–13 (S:18) contains only 9.1 percent ash. Considerable but variable amounts of gypsum occur in the lignite beds. No marcasite was observed. An appreciable amount of silicon and iron, and small amounts of magnesium, boron, titanium, zinc, calcium, barium, cerium, and lanthanum were found by spectrographic analysis of some of the lignite samples (table 5).

Some of the lignite beds have been burned at the outcrop. The burning has converted the shale and lignite to clinker and to ash, respectively, and has baked the sediments above and below for a few inches or a few feet. As observed by the senior author in North Dakota, this burning takes place only if the lignite is relatively close to the surface and about 5 feet or more thick. In the Red Desert many of the outcrops of lignite have been burned back for a short distance. These beds of clinker and ash are not delineated on the maps because they occupy only local areas (pl. 17), but some of these areas are listed below:

(1) Bed 2(?) east of the road on the north side of anticline at Monument Lake.
(2) Bed 1 along the north side of Pleistocene Monument Lake.
(3) Bed 1 northwest of Sourdough Butte.
(4) Bed 3 for a short distance east of the mouth of Sourdough Canyon.

RADIOACTIVITY

The amount of radioactivity of the lignite beds is indicated on plates 16 and 17. A. L. Slaughter and J. M. Nelson (unpublished report, 1946) found that radioactivity is not confined to the lignite seams; the interbedded layers of carbonaceous shale are also radioactive. For this reason, evaluation of the radioactivity of only the lignite seams, requires additional samples. Composite samples of the entire lignite bed were generally taken, in order to obtain a measure of the total radioactivity—information required in the experimental airborne survey. Treated as units, the lignite beds provide radioactivity meter-readings at their best outcrop (pl. 17) that range from a fraction to more than six times the local background. When using the car-mounted Geiger-Mueller counter an increase in counting rate is easily discernible in crossing radioactive lignite beds, or the ash and clinker formed by the natural burning of the lignite beds. For example, in driving over the small outlier of lignite bed 2, half a mile east of the road intersections on High Point Ridge (pls. 16 and 17), the meter readings increase from about 9.5 scale divisions over the

sandstone on either side, to about 11.5 scale divisions directly over the small area of lignite.

Airborne equipment was successful in detecting the radioactive lignite beds. The test flights, methods, equipment, and results are given by F. W. Stead (unpublished report, 1949) and Nelson and others (1951) and will not be given here. Radioactivity measurements obtained by carborne and airborne Geiger-Mueller traverses and the geology are shown on figure 57. The intensity of the radioactivity varies from bed to bed, and over long distances along the strike, but in general is remarkably constant in all beds.

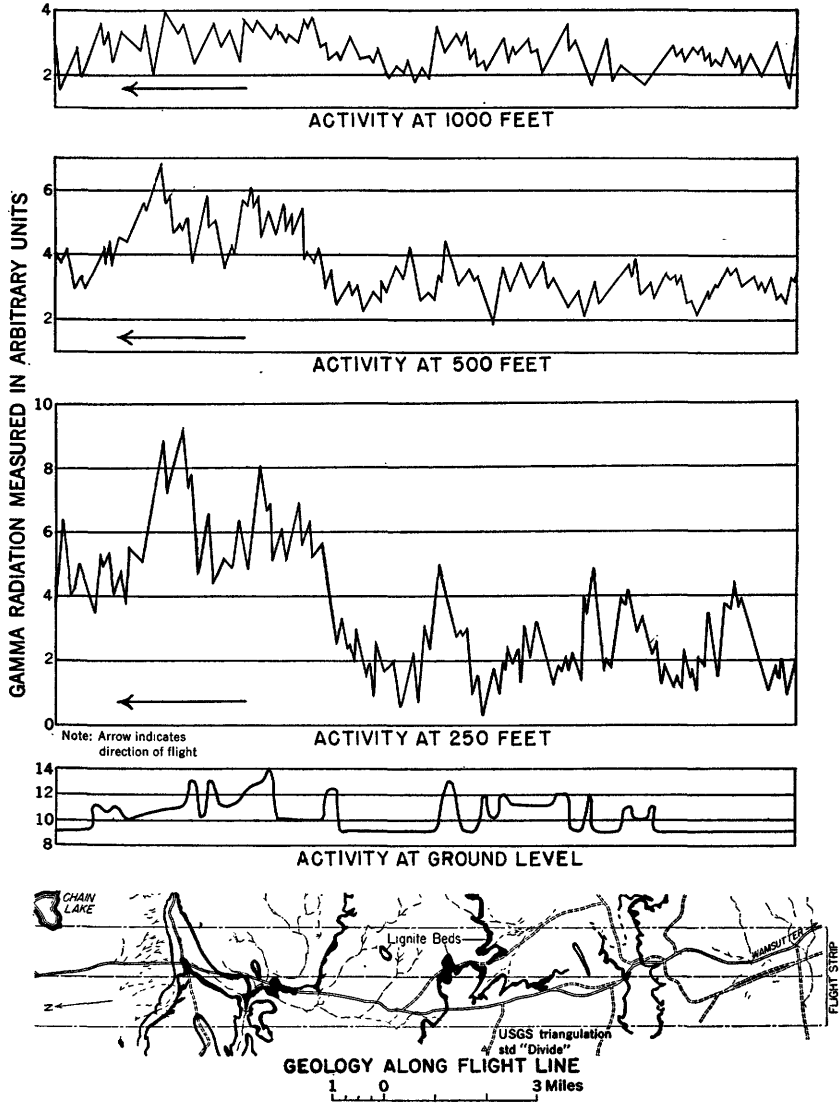

FIGURE 57.—Records of gamma radiation obtained from carborne and airborne counters.

Analyses of samples of lignite, carbonaceous shale, clinker, and ash from the flight-strip area over which the airborne equipment was used are shown in table 6.

Samples of lignite contain from 0.002 to 0.015 percent equivalent uranium and from 0.002 to 0.007 percent uranium. Most of these samples are composite samples of an entire bed and therefore include clay from interbedded carbonaceous shale. The combustion of lignite to an ash is a possible approach to the commercial production of uranium. Sample WNS–13 (S:18), representing 6 feet of high-quality lignite with very little interbedded shale, produced ash containing 0.015 percent uranium, as compared to the 0.002 percent uranium contained in the original material.

Isolated outcrops of radioactive lignite and paper-thin shale, in part burned to clinker, were found about 1¾ miles north of the northwest corner of Lost Creek Dry Lake. Radioactivity measurements at the outcrop suggest that the partly burned material contains about 0.006 percent equivalent uranium. This bed of radioactive lignite was mapped by Smith (1909, pl. 12).

Equilibrium status.—A sample of uraniferous rock in which radioactive equilibrium exists should contain as much uranium as equivalent uranium, unless elements of other radioactive series such as the thorium series are also present. Judged by the radioactivity of some samples not in radioactive equilibrium (table 6 and pl. 17), some of the lignites once contained more uranium than is indicated by the equivalent-uranium (eU) content, or else disintegration products (principally radium) have concentrated in the lignite. Analytical work by the Geological Survey has demonstrated that radioactive equilibrium noted in analyses of the samples is caused by an abnormal radium-to-uranium ratio; there is about 60 percent more radium than needed for the equilibrium ratio (John Rosholt, written communication).

The measured radioactivity of sample WNS–4 (S:5) is equivalent to a uranium content of 0.015 percent, on the assumption that uranium is in equilibrium with its disintegration products. Chemical analysis, however, shows that it contains only 0.003 percent uranium. Because in this arid environment uranium salts are relatively soluble in comparison to radium salts (sulfate, chloride, and carbonate), it may be presumed that much of the uranium and its preradium disintegration products have been leached out. If this is true, material of the sample, before leaching, would have contained more uranium than the 0.015 percent suggested by the equivalent-uranium content. Specifically, a uranium content of 0.026 percent would be required to give the observed radioactivity, if uranium and all its disintegration products were present and in equilibrium.

The simple calculations as evidence for this statement are shown below:

$0.003 \times 0.40 = 0.0012$ Percent equivalent uranium due to uranium and its preradium disintegration products

$0.015 - 0.0012 = 0.0138$ Percent equivalent uranium due to radium and its disintegration products

$0.0138 \div 0.60 = 0.023$ Percent uranium necessary for equilibrium with 0.0138 percent radium, and its disintegration products

$0.023 + 0.003 = 0.026$ Total percent uranium necessary for equilibrium

Sample WNS–17 (S:23), consisting of fragments of lignite, carbonaceous shale, and admixed surface debris, was picked from the sludge and cuttings of other rocks that accumulated in the sump during the drilling of a water well at the site of the California-Wyoming Development Co. oil well. This sample contained 0.011 percent equivalent uranium and 0.012 percent uranium. After burning in the laboratory, it contained 73.7 percent ash and 0.014 percent uranium in the ash. The sample, although small and impure, demonstrates that beneath the surface at this locality radioactive lignite contains uranium essentially in equilibrium with its daughter elements. The high ash content, due largely to extraneous surface debris, suggests that samples of the lignite free from such diluting material may contain appreciably more uranium.

ORIGIN

The process by which uranium accumulated in uraniferous lignite is not known, but two alternative suggestions have been made: (1) uranium is syngenetic, that is, it was carried by ground and surface water into the swamps in which plants and plant debris were accumulating, and was fixed before coalification either by absorption in the tissues of live plants or by absorption or adsorption, or by chemical reaction with, the carbon and organic material of plant debris; or, (2) uranium is epigenetic, that is, it was leached from overlying source rocks, such as beds of volcanic ash, by ground or surface water and carried down to be precipitated in or be adsorbed by lignite (Tolmachev, 1943).

In support of the epigenetic origin of uranium in coal, N. M. Densen, G. O. Bachman, and H. D. Zeller (unpublished report, 1950) have observed that (1) beds of uraniferous lignite in North and South Dakota occur in several formations, but only in those underlying Oligocene rocks and only those beds of lignite nearest the unconformity at the base of the Oligocene rocks are uraniferous; (2) uranium is concentrated near certain fractures and near the tops of the lignite beds; and (3) lignite beneath relatively impermeable strata generally contains less uranium than lignite beneath relatively permeable strata. They believe the source of the uranium to be volcanic ash in the White River formation of Oligocene age.

In the Red Desert and surrounding region in Wyoming there are rocks derived from volcanic ash (parts of the Bridger, Continental

Peak of Nace (1939), Chadron, and Brown's Park(?) formations of Eocene, Oligocene(?), and Miocene or Pliocene age), and also slightly radioactive igneous rocks (the rocks of the Leucite Hills).

The theory of epigenetic origin of the uranium in the lignite beds of the Red Desert is, on the other hand, difficult to accept for the following reasons:

1. At the outcrop some of the lignite apparently has been subject to leaching (see analyses of samples, table 6), and has lost part of its uranium content. If we assume an epigenetic origin for the uranium, as outlined above, it is difficult to understand how the leaching could have taken place; the lignite of the outcrops should be enriched, rather than impoverished, in uranium.

2. Lignite buried about 100 feet beneath impervious shale in Monument Dry Lake, and beneath as much as 300–500 feet of impermeable shale and other Eocene rocks at the site of the California-Wyoming Development Co. oil well, is uraniferous. If the uranium is epigenetic in origin, the lignite at these localities should not be uraniferous, because water carrying uranium could not percolate down through the shale. The lignite at the site of the oil well has apparently not been leached of its uranium content, as is indicated by the equilibrium relationship.

3. The radioactivity of the lignite beds is remarkably uniform along strike; no marked change in radioactivity was observed for 10 miles or more from High Point Ridge to Monument Dry Lake (pl. 17); the uranium content, however, is not uniform, a fact which could be attributed to differential leaching.

4. The evidence listed in support of an epigenetic mode of origin may be interpreted in several other ways; for example, in other types of uranium deposits secondary uranium minerals are commonly concentrated along fractures.

5. Autoradiographs of hard vitreous coal indicate a uniform distribution of radioactive material, a distribution difficult to explain by processes other than syngenetic processes.

It is the writers' opinion, therefore, that available evidence supports a syngenetic or at least pre-coalification origin for the uraniferous lignite beds in the Red Desert. However, a more thorough study of the region and of the physical chemistry of uranium and carbonaceous material is required before any theory of origin may be considered as demonstrated.

LOST CREEK SCHROECKINGERITE DEPOSIT

LOCATION AND HISTORY

The Lost Creek schroeckingerite deposit (pls. 19 and 21) is 38 miles north of Wamsutter (index map, pl. 16) on the east side of Lost Creek, near the Kleber Hadsell shearing pens and cabin. The deposit is in

secs. 30 and 31, T. 26 N., R. 94 W., sixth principal meridian, and may be reached from Wamsutter, the nearest railroad station, by traveling 43 miles on a graded desert road.

The country surrounding the deposit, which occupies a broad open valley, is relatively flat but slopes gently southward. A mile north of the deposit a series of northwest-trending ridges rises a hundred feet or more above the general land surface. Farther west, these ridges are as much as 500 feet above the general land surface and form the Cyclone Rim escarpment. About 13 miles north of the deposit the Green Mountains and Antelope Hills form the northern rim of the Great Divide Basin.

Lost Creek rises in the Green Mountains, but a few intermittent streams from the east are tributary to it. It drains into Lost Creek Dry Lake when in flood, but is seasonally intermittent below the schroeckingerite deposit.

The schroeckingerite deposit was discovered in 1936 by the late Mrs. Minnie McCormick. The deposit is covered by the placer mining claims, Golden Arrow Nos. 1 to 9, filed by the late Mrs. Minnie McCormick and her associates, Louis A. McCormick, Mrs. Mabel A. McVae, Mrs. Emma J. Eversole, Mrs. Laura E. A. McCargar, Kleber H. Hadsell, and Tom W. Whelan. Since the time of filing, C. A. Brimmer has been added to the list of owners. The property was leased with option to buy in January 1948 to Uranium Inc., Denver Colo., whose president is Walter Byron, and whose members include K. W. Robinson, R. D. Charlton, and Robert Swanson, also of Denver.

Many geologic examinations of the deposit have been made: (Knight and Gilbert, 1937 [4]; Dake, 1938; Harder and Wyant, unpublished report, 1944; Guillotte, G. B., unpublished report, 1945; Slaughter and Nelson, unpublished report, 1946; C. C. Towle, unpublished report, 1948; and D. G. Wyant, unpublished report, 1949).

The exploration work at the deposit—carried out for Uranium Inc., by the Minerals Engineering Co. in 1948—consisted of about 3,900 feet of trenches, 13 pits, a few bulldozer cuts, and many auger holes. The average maximum depth reached in this exploration was about 5 feet beneath the surface, but most of the excavations were caved or filled by surface wash before the summer of 1949.

The field work in 1949 was done by D. G. Wyant, W. N. Sharp, and H. L. Bauer, Jr.; in 1950, D. M. Sheridan carried out the prelimary deeper auger testing. During about 2½ weeks in 1949, a planetable map and geologic sections of some of the trenches were made, and 39 shallow auger holes were bored. During about 8 weeks in 1950, 13 deeper auger holes, totaling 397 feet, were bored and 208 samples were taken for analysis.

[4] The geologic occurrence, chemical composition, and optical properties of a new uranium mineral: unpublished paper presented before the chemistry section of the Am. Assoc. Adv. Sci. at Denver, Colo.]

GEOLOGIC SETTING

The Lost Creek deposit, the largest deposit of schroeckingerite now known, is located within the Cyclone Rim fault zone, in an area predominantly of Wasatch-type green claystone, arkosic sandstone, and grit, and subordinately of thin interbeds of Green River-type platy shale. The Bridger formation and the Continental Peak formation of Nace (1939) are also possibly represented. The deposit is made up of several thin, irregular tabular mineralized bodies either in beds of platy shale of the Green River formation at their contact with beds of sandstone of Wasatch type, or in gray-green silty claystone of Wasatch type. These beds have been folded, faulted, eroded, and covered by successive terrace deposits of Pleistocene to Recent gravel, silt, alluvium, and colluvium. The Pleistocene terrace deposits shown on plate 19 indicate at least two periods of terrace formation. The older, or upper terrace surface, is probably continuous along Lost Creek to a point where it leads into the delta-fan of Pleistocene Lost Lake in the vicinity of Eagles Nest.

About 1½ miles north of the deposit, near Soda Lake (pl. 16), the northeast-dipping Eocene strata are overlain unconformably by the Oligocene(?) Chadron formation of Nace's usage (Nace, 1939, pp. 31–35).

Lithology.—The deposit is very near the eastern margin of several thin tongues or lentils of the Green River formation and presumably, therefore, near the former fluctuating margin of one of the Eocene Green River lakes. Shale of the Green River formation ranging in thickness from 0.1 foot to about 30 feet, is exposed in units *d* and *h* of outcrop *A* (pl. 19), in the principal mineralized bodies (for example, in pit 8 and trench L), and in the bluff of Lost Creek. Plate 20 illustrates the repetition of the shale strata of the Green River at different stratigraphic positions in the trenches. Many of these thin beds are contorted, and weather to curved plates. In these beds ostracods were observed 60 feet east of the northeast corner of the Hadsell shearing pen (outcrop (*a*), pl. 19), and from them fragments of vertebrate fossils were collected (unit *h*, outcrop *A*, pl. 19).

Outcrops are sparse. The lithology of most outcrops is summarized in the following paragraphs. In outcrop *A*, west of the road fork in the south-central part of the mapped area, nine lithologic units are exposed: unit *a* is brown claystone containing some white sandstone; unit *b* is gray-green platy shale; unit *c* is white coarse-grained arkosic sandstone that is in fault contact with units *d* and *e*, which are respectively shale of the Green River and blocky gray shale (the sandstone is stained orange brown along the fault); unit *f* is white coarse-grained sandstone, stained orange brown by iron oxides along its upper contact with unit *g*, a dark-brown claystone; unit *h* is brown shale of the Green River containing a few vertebrate fossils;

and unit *i* is gray-green claystone and gypsiferous sandstone, partly obscured by colluvium.

Outcrop *B*, shown near the center of the north edge of the mapped area, includes six stratigraphic units: unit *a* is light-green clayey sandstone; unit *b* is green gypsiferous claystone containing schroeckingerite; unit *c* is white-weathering brown conglomerate; unit *d* is green claystone and some sandstone, containing schroeckingerite pellets and gypsum; unit *e* is gray-green silty gypsiferous claystone; and unit *f* is arkosic conglomerate and green silty gypsiferous claystone that contains large pellets of schroeckingerite.

Outcrop *C*, west of outcrop *B*, is composed of 2 units: *a*, white-weathering brown sandstone, and *b*, medium-grained green sandstone and some claystone. Outcrop *D*, north of the Hadsell shearing shed, exposes brown claystone but may also include some shale of Green River type.

In addition to these outcrops, 8 outcrops too small to delineate as areas but plotted as points on plate 4 are as follows:

Outcrop (*a*), near the Hadsell shearing shed, contains platy brown shale of the Green River; in outcrop (*b*), near outcrop (*a*), green sandstone is exposed; outcrop (*c*), at the creek bank by the bridge, consists of green claystone in which pellets and flakes of schroeckingerite are concentrated in an irregular zone 2 inches thick adjacent to an overlying iron-stained solution zone in sandstone; outcrop (*d*), about 400 feet northeast of the bridge, exposes green-gray claystone containing schroeckingerite pellets; outcrop (*e*), north of Osborne Draw, exposes gray- and maroon-mottled claystone; outcrop (*f*), near outcrop (*e*), contains green, chocolate, or maroon sandy claystone; in outcrop (*g*), south of trench *K* in the west-central part of the mapped area, pellets of schroeckingerite are in gray-green platy shale above iron-stained sandstone; and in outcrop (*h*), 50 feet east of outcrop (*g*), schroeckingerite pellets are in green claystone.

The lithology as seen in, or as deduced from the material on dumps of shallow auger holes, pits, and bulldozer cuts is listed below:

Pits and bulldozer cuts

Reference no. (*pl. 19*)	*Lithologic description*
1	Claystone, green, silty; contains schroeckingerite pellets.
2	Claystone, gray-green; contains schroeckingerite pellets and flakes; overlies iron-stained solution zone in green, clayey sandstone.
3	Silt (terrace deposit).
4	Shale, gray-green, platy; contains schroeckingerite pellets and gypsum.
5	Gravel, white to brown (terrace deposit).
6	Gravel (terrace deposit).
7	Sand, white, and brown clayey sand and gravel (terrace deposit).

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Pits and bulldozer cuts—Continued

Reference no. (pl. 19)	*Lithologic description*
8	Shale, gray, platy, weathering to curved plates; contains schroeckingerite pellets; overlies iron-stained solution zone in white sandstone.
9	Siltstone, green, sandy; contains schroeckingerite pellets; underlies basal boulder-gravel bed of terrace deposit.
10	Sandstone, white to brown, clayey, and colluvium.
11	Gravel, brownish white, clayey (terrace deposit).
12	Gravel (terrace deposit).
13	Claystone, gray; contains schroeckingerite pellets and white efflorescent salt.
14	Claystone, gray-green; contains schroeckingerite pellets, and sandy siltstone. (Pit contains water.)
15	Gravel of subrounded frosted quartz and feldspar grains (terrace deposit).
16	Siltstone, green; contains schroeckingerite (dump material from filled pit).
17	Gravel, white to buff, and green sand (terrace deposit).
18	Shale, gray-green and purple, platy; contains schroeckingerite pellets; overlies brown-stained solution zone in white sandstone.
19	Siltstone, green, clayey; contains schroeckingerite pellets; overlies iron-stained solution zone in white micaceous sandstone.
20	Shale, gray-green, platy; contains flakes of schroeckingerite; overlies iron-stained solution zone in white sandstone and conglomerate (faulted).
21	Claystone, gray-green, overlying orange-stained white sandstone; contains no schroeckingerite.
22	Siltstone, green; contains schroeckingerite pellets, and overlies iron-stained sandstone on west and north sides of pit; platy grey-green shale with no schroeckingerite, overlies siltstone on south and east sides of pit (faulted).
23	Sand, green, clayey (terrace deposit); overlies gray-green gypsiferous claystone.
24	Shale, gray, platy, weathers to curved plates; contains schroeckingerite pellets; overlies iron-stained solution zone in white sandstone; claystone seams 10 and 17 inches below contact also contain schroeckingerite.
25	Sand, gray-green, and clayey sand (terrace deposit).
26	Sand, greenish white, and gravel (terrace deposit).
27	Shale, gray-green, platy; contains schroeckingerite pellets; overlies iron-stained solution zone in white sandstone.
28	Shale, gray-green, platy; contains schroeckingerite pellets; overlies iron-stained solution zone in white sandstone.
29	Gravel (terrace deposit) fills pit.
30	Sand, white-weathering, brown (terrace deposit); fills pit.

Shallow auger holes

H–3	Claystone, maroon, sandy.
H–4	Claystone, green, gravelly.
H–5	Gravel (terrace deposit).
H–6	Gravel, white-weathering, brown (terrace deposit).

Shallow auger holes—Continued

Reference no. (pl. 19)	*Lithologic description*
H–7	Gravel, white-weathering, brown, and some white clay (terrace deposit?).
H–8	Claystone, light-green, silty.
H–9	Sand, white-weathering, buff and green, and gravel; gravel contains fluorescent chalcedony (terrace deposit?).
H–10	Sand, green (terrace deposit).
H–11	Clay, green, and gravel (terrace deposit).
H–12	Claystone, green.
H–13	Claystone, green.
H–14	Gravel, green (terrace deposit).
H–15	Gravel (terrace deposit); hole is filled.
H–16	Gravel (terrace deposit); hole is filled.
H–17	Sand and gravel (terrace deposit); overlies green sandy siltstone; hole is filled.
H–18	Sand and gravel (terrace deposit); overlies green sandy siltstone; hole is filled.
H–19	Shale, gray-green, platy; contains schroeckingerite pellets, and brown sandstone; hole is filled.
H–20	Silt, buff (terrace deposit).
H–21	Sand, white (colluvium).
H–22	Sand, white, coarse (colluvium and terrace deposit).
H–23	Gravel (terrace deposit); hole is filled.
H–24	Shale, gray-brown, platy; schroeckingerite?; hole is filled.
H–25	Gravel (terrace deposit, colluvium); hole is filled.
H–29	Claystone, brown.
H–31	Sandstone, green, silty.
H–33	Claystone, gray, silty; contains schroeckingerite.
H–34	Claystone, gray, silty; contains schroeckingerite.
H–35	Sand and gravel (terrace deposit).
H–36	Clay, green, sandy (terrace deposit?).
H–37	Claystone and sandstone, iron-stained.

Trenches *F*, *G*, *H*, *I*, and *P* (pl. 19) were filled or caved in the summer of 1949, although some information concerning lithology and ore zones was gathered by inspecting the dump material. Trenches I_1, *J*, J_1, M_1 were not deep enough to expose bedrock below the Pleistocene terrace deposit. Vertical sections were prepared of trenches *C*, *E*, E_1, *L*, and *N*. The other trenches were open but were not mapped because the time was too short. The general relations between the various type of sediments and schroeckingerite in these five trenches are shown on plate 20.

Additional lithologic data obtained from cuttings of shallow auger holes drilled in 1949, and from deeper auger holes drilled in 1950 are tabulated in the section Auger-hole data (tables 10 and 11).

Structure.—The deposit is within the Cyclone Rim fault zone that separates folded beds to the northeast from nearly horizontal beds to the southwest. (See cross sections *A–A′* and *B–B′*, pl. 19.) Faults within the Cyclone Rim fault zone were first observed while measuring columnar section 9, about 8½ miles northwest of the

deposit (pl. 16). These faults strike N. 50°–70° W., dip vertically or steeply to the south, and individual faults displace the beds on the southwest side downward as much as 33 feet. Within the schroeckingerit deposit, minor faults, ranging in strike from N. 70° to 85° E., and in dip from 25° to 53° SE., were mapped in trench *C*, trench *A*, pit 21, and outcrop *A*. Offsets on these faults appear to be small but were not positively demonstrated.

In general, the sediments within the deposit strike northwestward and dip northeastward. Their strikes, as determined in trenches and pits, range from N. 89° W. to N. 72° E. but average about N. 65° W.; dips range from 4° to 42° NE., and average about 20° NE. In trench *L*, pit 8, and in the bluffs of Lost Creek below the bridge, the beds strike northeastward and appear to be continuous between exposures, which suggests that they have been folded rather than faulted. The nearly east direction of strikes in pit 2, trench *O*, pit 4, and trench *N*, may also reflect the attitude of such a postulated fold rather than the effects of local faulting or "surface creep."

It is possible that most of the ore bodies are along fault surfaces that parallel bedding surfaces. Natural exposures are too few and exploration too shallow to afford adequate observation of this relationship.

MINERALOGY

The principal uranium mineral in the deposit is schroeckingerite, but fluorescent uraniferous opal, and undetermined minerals of uranium also occur.

SCHROECKINGERITE

Schroeckingerite, $NaCa_3(UO_2)(CO_3)_3(SO_4)F{\cdot}10H_2O$, is a bright yellowish-green mineral that contains about 27 percent uranium. Under ultraviolet light the mineral fluoresces an even brighter yellowish-green than it appears in white light. Schroeckingerite, hand-picked from Lost Creek ore, and estimated to contain only 1 percent of impurities (sand, clay, etc.) contains 11.0 percent equivalent uranium and 24.5 percent uranium; the discrepancy between the analytical and theoretical uranium content may mean that the Lost Creek material analyzed contained nearly 4 percent impurities. The smaller equivalent uranium content reflects a relative deficiency in radium and indicates that the schroeckingerite formed so recently that the uranium and its disintegration products have not yet attained radioactive equilibrium. The optical properties determined by Joseph Berman correspond closely to those reported by Jaffe, Sherwood, and Peterson (1948). Other work concerning the mineralogy of this mineral has been done by Schrauf (1873), Larsen and Gonyer (1937), Knight and Gilbert (see footnote 4, p. 255) (1937), Dake (1938), and Nováček (1939).

Some loose pellets of schroeckingerite, observed in the rock debris at the base of the bluff below the bridge and in the dumps of the trenches, appear to differ from normal schroeckingerite. These pellets are harder, slightly more yellow than the normal yellowish green, and are commonly encased by a reddish-brown shell; they may possibly be dehydration forms of the mineral or may be schroeckingerite slightly modified by the addition to or loss from the molecule of some components other than water.

In the Lost Creek deposit, schreockingerite has 3 characteristic modes of occurrence: 1, as round aggregates or pellets, as much as three-fourths of an inch in diameter, made up of platy crystals; 2, as individual, small flaky crystals; and 3, as 1 millimeter-thin layers made up of numerous small crystals that coat grains of quartz, calcite or other sandstone components or the surface of efflorescent salts. The mineral also occurs, rarely, in microscopic fibrous masses in silica and calcium carbonate.

The pellets, concentrations of which constitute the ore bodies, seem to occur preferentially within brown, gray, or varicolored shale of the Green River formation or in massive gray-green silty claystone or clayey siltstone of Wasatch type. Some pellets fill shrinkage cracks in the claystone. The commonly associated minerals, other than the predominant clay minerals of the montmorillonite group and quartz of silt-size, as determined by Joseph Berman in hand specimens of typical pelletal schroeckingerite ore, are gypsum, aragonite, calcite, and iron-oxides.

The individual thin flaky crystals of schroeckingerite that are commonly disseminated in loose sand or sandy clay, as well as the thin layers coating other minerals at the ground surface attest to the ready solubility and mobility of schroeckingerite in cold water. The mineral is periodically dissolved by rain and melting snow and carried down the slopes, where it recrystallizes upon drying as a surface incrustation. During the winter season of 1948–49, the individual crystals and pellets exposed on the dumps of the trenches dissolved and, during the dry season of 1949, recrystallized as thin efflorescent coatings of the ground below the dumps; these coatings cover areas as much as 20 feet square. Schroeckingerite is also readily dissolved and transported by near-surface ground water from which the mineral reforms on evaporation, so that a blanketlike thin layer of disseminated schroeckingerite flakes commonly coats shale beds or claystone that immediately underlie porous terrace sand and gravel, or colluvium. A specimen representative of this type of occurrence from the older terrace deposit (Qt_2) at pit 18, overlying an ore body that was examined by Berman, consists of a friable, porous arkose composed predominantly of subrounded grains of microcline and a moderate amount of quartz; the grains are loosely bonded by small amounts of

clay and calcium carbonate. Small specks of fluorescent material are probably schroeckingerite. Such widespread dispersion of the mineral, although an aid in prospecting, hampers the finding of ore bodies; the thin coatings, although a spectacular sight under ultraviolet light, are not ore.

OTHER URANIUM MINERALS

Unknown uranium-bearing minerals or substances are present in the deposit and in the adjacent rocks, as was first noted by Slaughter and Nelson (unpublished report, 1946), who took samples of claystone that was radioactive but contained no visible schroeckingerite. One of these samples contained 0.018 percent equivalent uranium and 0.004 percent uranium; another contained 0.019 percent equivalent uranium and 0.039 percent uranium. The presence in the first sample of a probable excess of radium (analogous to some of the radioactive lignite), and in the second of a probable excess of uranium, certainly indicates the presence of other uranium minerals or uranium-bearing substances. Sample WNS–5–233, of a 3-inch bed of white ashy material from trench K_2 (pl. 21), contains 0.025 percent equivalent uranium, 0.011 percent uranium; the sample is composed of dolomitic calcite containing minor amounts of subrounded particles of partly devitrified volcanic glass(?) and quartz silt, Joseph Berman (written communication). A sample, DW–108–305, of gypsiferous sandstone from Arapahoe Creek contains 0.005 percent equivalent uranium and 0.003 percent uranium (table 3). The sample, according to Berman, is composed of albite, gypsum, calcium carbonate, clay, some oligoclase and rose quartz, and small amount of microcline, altered rhyolite, and biotite. The oligoclase is largely altered to sericite. Fluorescent, radioactive agate pebbles occur at the Lost Creek deposit. In 1948 C. C. Towle and the senior author took samples of terrace deposits and of green clay in which no schroeckingerite was observed but which contained as much as 0.011 percent equivalent uranium and 0.006 percent uranium (sample TW–13, table 7).

Schroekingerite is associated with small amounts of fluorescent uraniferous opal, carbonate, and gypsum, and with nonfluorescent uranium minerals (or adsorptions on clay). During the program of auger-testing in the fall of 1950, material having fluorescent characteristics similar to those of schroeckingerite was found in all the holes bored. The fluorescent material was first thought to be schroeckingerite, but analyses show it does not contain as much uranium as schroeckingerite. M. E. Thompson determined the material to be, in part, opal; in part fluorescent calcite; and in part, an unidentified constituent. Examination of samples under ultraviolet light with a binocular microscope indicated that many fluorescent clots, which megascopically appeared to be small clots of schroeckingerite, are in reality grains and aggregates of other minerals with thin, irregular

coatings of schroeckingerite. Some of these other minerals, notably opal, calcite, and gypsum are also fluorescent.

Sample WNS–20 (S:28), of dull-yellow-fluorescent gypsiferous claystone from the west side of Lost Creek about 1¼ miles northwest of the Hadsell shearing sheds, contains 0.004 percent equivalent uranium, 0.002 percent uranium (table 3). The sample, as examined by Berman, is an argillaceous siltstone containing substantial amounts of gypsum. The clay is a physical mixture of an illite-type clay mineral and kaolinite. The silt particles are principally feldspar and quartz.

Some samples containing as much as 0.019 percent uranium contain only a relatively small amount of schroeckingerite. It is possible that uranium may be adsorbed in clay aggregates in some of these samples.

Semiquantitative spectrographic analyses of some of the auger-hole samples have been made by Paul R. Barnett. Major constituents other than silicon and iron are calcium, barium, magnesium, and titanium. It is likely that barium and radium occur together. As much as 0.0X percent vanadium, manganese, lanthanum, and cerium were found in some samples.

ORE BODIES

The schroeckingerite ore bodies at the Lost Creek deposit are shown on plate 19. The examination of the rock exposed in open trenches and pits and of the rock fragments in the dumps of auger holes and filled trenches and pits suggests that the more continuous ore bodies occur either in platy shale overlying sandstone or in gray-green massive silty claystone. The shale-sandstone type of ore body, which appears to predominate, is in detail, as follows: white friable sandstone of Wasatch type is overlain sharply by gray platy (commonly contorted) shale of Green River type. A thin zone, 1–8 inches thick, largely but not entirely in the sandstone, at the contact of shale and sandstone is invariably stained brown, orange, or purple by iron and manganese(?) oxides. Pellets of schroeckingerite are commonly disseminated in the shale parallel to the iron oxide-stained zone and only occasionally within the zone, although flakes of schroeckingerite may be sparsely disseminated in it.

A typical ore body of the shale-sandstone type (pl. 20) is from 6 to 15 inches thick, the average is 1 foot in thickness, and extends 5 feet or more vertically beneath the surface (pl. 19, trench D_1; pl. 20, trench L). The maximum vertical depth to which schroeckingerite has been found is 8 feet, in pit 18 and in trench C, and was a distance of 37 feet down the dip of the ore body.

The length of individual ore bodies is unknown. The longest distance explored along the strike of a bed is 150 feet in trench D_1.

The schroeckingerite ore body in this trench extends, with a gap of about 100 feet, into pit 18 and is exposed by trench *C*. There is no apparent diminution in grade throughout the length explored. Therefore, it is reasonable to assume this body is continuous between exposures and that it is at least 270 feet long.

Schroeckingerite in shale overlying iron-stained sandstone (the shale-sandstone type of ore body) is found in nearly all trenches that are deep enough to expose bedrock. This shale-sandstone sequence of beds seems to be the most favored association for schroeckingerite, but this sequence is not invariably schroeckingerite bearing. In trench *C*, about 62 feet from the southeast end, and in pit 21 this characteristic favorable sequence of beds is barren of schroeckingerite.

The schroeckingerite body of the shale-sandstone type exposed in the bluff of Lost Creek west of trenches *K* and *L* projects directly into the exposure of the body in trench *L*, thence into pit 8, and—if the interpretation of structure is correct—from pit 8 around a sharp fold into trench *K*. An auger hole, H–19, about 110 feet southeast of this shale-sandstone body in trench *K*, intersected the same deposit. From this point southeastward to trench *I* there are no exposures. The platy shale and schroeckingerite pellets in the dump at the southwest end of trench *I* are approximately on the trend of the schroeckingerite body and are assumed to be its southern extension. Two shale-sandstone ore bodies at the northeast end of trench *A* may be projected through trench *E*, possibly as far as trench *F*.

The continental sedimentary rocks in this area are characteristically nonpersistent, lenticular, and their contacts may be in part fault contacts; thus, the projection of shale-sandstone contacts and associated schroeckingerite bodies is somewhat questionable. In addition, the ore bodies are in the Cyclone Rim fault zone where the beds should be expected to be displaced by faults.

Schroeckingerite in gray-green silty claystone or clayey siltstone is exposed in trench *L*, pits 13 and 14, trench K_2, the southwest end of trench *F*, trench *C*, pit 1, and outcrop (*d*).

Thin stringers or mantles of schroeckingerite pellets and flakes that are too thin and irregular to constitute potential ore occur along the bluff of Lost Creek below the bridge, and near the edge of the colluvium in outcrop *A*; in a similar position in outcrop *B*; and in trench *P*. These occurrences are probably the result of the re-formation of schroeckingerite from ground and surface water that has passed over or through schroeckingerite-bearing material elsewhere.

GRADE

The grade of samples of schroeckingerite-bearing material that have been taken from the Lost Creek deposit since 1948 ranges from 0.013 to 0.28 percent uranium.

The analyses of samples of schroeckingerite-bearing material, water, plants, and soil taken by the Minerals Engineering Co. and by the Geological Survey are given in tables 7, 8, and 9. The analyses of rock samples (table 7) disclose discrepancies between equivalent-uranium and uranium contents, and differences in the uranium content of samples taken by the Minerals Engineering Co. and those taken by Towle and Wyant. Some of the discrepancies may be attributable to sampling procedures. The report by George Petretic, Geological Survey, accompanying the analyses of the samples taken by Towle and Wyant (table 7) stated:

> . . . the correspondence between the percent eU [equivalent uranium in table 7] determined by reference to a standard in which uranium is in equilibrium with UX_1 and UX_2 only and percent uranium is good except for samples 5828 (TW–17), 5836 (TW–25), and 5837 (TW–26). Although this agreement is not good, it can be attributed to the non-homogeneity of the samples. The schroeckingerite is dispersed throughout the matrix of feldspar, etc., and observation of the samples under an ultra-violet lamp clearly shows that a non-representative sample can easily be obtained, particularly if less than a gram is used for analysis.

The difference in analyses may be attributed in part to differences in the sampling procedure, and in part to the fact that schroeckingerite is erratically distributed in the ore bodies and that this soluble mineral is in process of being redistributed by ground and surface water. Bulk sampling probably is the only way to obtain representative samples.

The analyses of water samples (table 8) show an abnormal uranium content in the ground water underlying the deposit (as much as 0.88 parts per million). The spring at the mouth of Osborne Draw (northwest part of map, pl. 19) is probably a seep of near-surface water, possibly localized by fracturing or faulting. It is of interest to note that there is a seasonal fluctuation of the uranium content of the spring water. Sample WNS–9–13 of water from pit 14 contains much more uranium (46 parts per million) than do many other water samples. This is not surprising, inasmuch as the schroeckingerite-bearing material in this pit was exceptionally high grade, and as the water (in direct contact with this ore) had been stagnant in the pit for at least four months. The ground water is mildly alkaline (pH of 7.8–8.3).

The plant and soil samples also show abnormally high uranium contents (table 8). A sample of greasewood roots (P 4) contains 7,400 parts per million in the ash, according to Helen Cannon (written communication), who states ". . . so far as I know, this is the highest value for uranium ever reported in a plant." The greasewood plant was growing on a schroeckingerite body (exposure *d*, pl. 19).

AUGER-TESTING PROGRAM OF 1950

A program of auger drilling was begun at the Lost Creek schroeckingerite deposit on October 23, 1950, and was recessed on December 20,

1950. The drilling was done with a jeep-mounted auger-drill rig equipped with augers 4¾ inches in diameter.

The objectives of the auger-drilling program were (1) to determine the maximum depth at which schroeckingerite occurs, (2) to obtain preliminary data about the lateral distribution of schroeckingerite, and (3) to determine more accurately the relations of schroeckingerite to beds of different lithology and to the Cyclone Rim fault zone.

Because of contamination inherent in the auger-drilling method, assays of auger-samples were not expected to give representative grades of schroeckingerite ore bodies; it was hoped, however, that such bodies could be delineated by means of these assays.

SAMPLING AND LOGGING PROCEDURES

Thirteen auger holes, totaling 397 feet, were drilled to depths ranging from 9 to 51 feet. The location of these holes is shown on plate 21. Eleven (holes ES–1 to ES–3 and ES–5 to ES–12), are along line of section *C–C′* shown on plate 22 and are oriented approximately perpendicular to the average strike of the ore bodies. These holes were spaced at intervals of 2–23 feet apart near known ore bodies in the trenched area, and at intervals of 163–1,000 feet apart, where remote from known ore bodies. Hole ES–13 was collared at a point 2,000 feet S. 60° E. from the northernmost end of section *C–C′* and hole ES–4, at a point 2,200 feet N. 45° W. from the southernmost end of section *C–C′*.

Samples were taken from top to bottom of the hole at 2-foot intervals except where changes in lithology made a different sample interval preferable or where drilling difficulties required special sampling intervals. For example, drilling below the water table required large sample intervals, in order to save time and insure better recovery. Each sample for analysis consisted of all the rock recovered from the interval being drilled, except for small samples removed for lithologic collections. Whenever the sample was obviously contaminated, such information was noted. A total of 198 rock samples for analysis was taken from the 13 auger holes.

Samples of the dry rock above the water table were collected by spinning the auger without lowering or raising the position of the bit, so that the rock traveled up the spiral auger and accumulated on a flat steel plate. This procedure was fairly satisfactory, but contamination by wall rock of the hole was unavoidable. For example, a 2-foot auger sample may consist entirely of clay mixed with sand and may assay 0.050 percent uranium. These data cannot be interpreted to mean that the sample represents an ore body 2 feet thick consisting of sandy claystone because the schroeckingerite may have been concentrated in any fraction of the 2-foot interval with a correspondingly higher grade in that fraction, and may all occur in the claystone and

not in the sandstone. By the time the sample reaches the surface it has undergone considerable mixing and the ore minerals may be scattered through the entire sample; caving may also add the ore minerals to succeeding samples.

In the drilling of holes below the water-table, sampling required the removal of rods after each sampling-run so that they could be stripped clean of adhering mud and ice.

Sample logs of each hole were made during the drilling and small representative samples of individual lithologic units were collected to preserve a record of each hole. A sample was taken of water in each of the 10 holes in which the water table was reached (all holes except ES–1, ES–11, and ES–13), and gamma-ray logs of each hole were made with a Geiger-Mueller counter to which a 2-foot gamma probe was connected by 50 feet of cable. In several holes caving prevented probing the total depth of a hole and the total footage of radiometric logging is only 326.5 feet, as compared to 397 feet of hole drilled.

Dry auger-samples were examined at night with an ultraviolet lamp having its highest efficiency at a wave length of 2540 ångstrom units. The schroeckingerite content of each sample was estimated on the basis of yellowish-green to greenish-yellow fluorescence. Radioactivity examination of these dry samples was made with a Geiger-Mueller counter, using a small probe with the beta shield open. The lithology, depth of sample, the radioactivity of samples determined in the field, the laboratory analyses of samples, and the gamma-logs of the bore holes are given in table 11.

In summary, the auger-drilling program allowed the determination of the general sequence of subsurface lithology and the determination of approximate locations, but not specific dimensions of schroeckingerite ore bodies. The grade figures calculated from the analyses are, at best, of value only in determining the uranium content of large intervals of rock.

GEOLOGIC RESULTS

The subsurface lithology determined during the auger-testing program and tabulated in the sample logs (table 11) has been plotted on geologic cross sections at scales of 1 inch to 200 feet (holes ES–2, and 3, and ES–5–ES–12, pl. 22) and 1 inch to 20 feet (all holes except ES-1, pl. 23). The locations of all auger holes are shown on plate 21. Hole ES–1, abandoned at a depth of 9 feet, is only 2 feet from hole ES–2, and no section of it was prepared.

Holes ES–2, ES–3, ES–5, and ES–6 are near enough to each other to permit a general correlation of beds, aided in part by data from previous geologic mapping in the trenches. In the vicinity of these holes the lenticular beds of sandstone, siltstone, and claystone (trench

C, pl. 20, and pl. 23) show on a small scale the interfingering relationship that the Wasatch-type sandstone and claystone have to shale of the Green River formation elsewhere near Eagles Nest (pl. 16) on a larger scale. Faults, if present, were not recognized. The other auger holes were spaced too far apart to permit intercorrelation of the beds.

Hole ES–11, located just south of the southeastern limit of the Cyclone Rim fault zone, is mainly in brown, hard, platy shale and small amounts of interbedded sandstone. Holes ES–1 to ES–6, all in the trenched area, and holes ES–7, ES–8, and ES–10 are in a series of interbedded sandstone, siltstone, and claystone with scattered iron-stained zones at the contacts of sandstone and claystone beds, but hole ES–9, 29 feet in depth, is almost entirely in pebbly sandstone with only minor amounts of siltstone and no claystone. Hole ES–12 cut beds of siltstone and claystone with only minor amounts of sandstone. Hole ES–13 penetrated sandstone and subordinate amounts of interbedded siltstone and claystone beds.

The most notable features of the general lithology described above are the thick sections of sandstone in holes ES–9 and –13, as compared with the sequence of siltstone and claystone in hole 12 and the sequences of sandstone, siltstone, and claystone in the other holes. Hole ES–9 is on the south flank of a ridge trending northwest (pl. 16), whereas hole ES–13 is on the north flank of the same ridge; hole ES–12 is at the foot of this ridge on its northeastern side.

Aerial photographs suggest that this ridge is formed of sandstone, and this is corroborated by the sandy character of the beds cut in holes ES–9 and ES–13. The shale penetrated in hole ES–12 suggests that a claystone sequence begins immediately north of the sandstone ridge. The data obtained by drilling indicate that the stratigraphic interval between the beds seen at the southwestern limit of the Cyclone Rim fault zone (pls. 16 and 19) and those cut in hole ES–9 (pl. 21) is occupied by relatively thin sandstone beds with a high proportion of claystone, shale, and siltstone beds, whereas the stratigraphic interval between the beds of hole ES–9 and those of hole ES–12 (pl. 21) is occupied by relatively thick sandstone beds with a low proportion of claystone and siltstone beds. Another sequence predominantly of shale and siltstone beds extends for an unknown distance northeast of hole ES–12.

DISTRIBUTION OF URANIUM

Visual estimates of the schroeckingerite content of each auger sample were made on the basis of fluorescence and auger samples were then analyzed by the Geological Survey (table 11). A comparison of uranium content determined by chemical analysis with the preliminary estimates of schroeckingerite content made in the field disclosed

several discrepancies: (1) in some samples the uranium content estimated from the amount of fluorescent material was much greater than that determined by chemical analysis, and (2) in some other samples opposite relationship was true.

For example, the average of estimates made by three observers of the schroeckingerite content of sample DS–2–10 (hole ES–2, table 11) is about 1 percent. Schroeckingerite contains about 27 percent uranium; therefore, this sample should have contained about 0.27 percent uranium. Actually, it contained only 0.049 percent uranium. Three sources of error may account for this type of discrepancy: (1) errors in preparation or analysis, (2) errors in estimation of schroeckingerite content, and (3) the errors caused by the presence of fluorescent material other than schroeckingerite. Accordingly, an effort was made to check these possible sources of error. To check the methods of preparation, 6 representative samples were prepared by hand—pulverized on a buckboard, ground in an agate mortar, mixed in a sampling cloth, and a representative split taken—and were then analyzed. The results are shown in table 12. With one exception (sample DS–5–80), probably the result of an uneven original split, the resulting assays agree very closely with the original assays and the assays of the laboratory-prepared split, and indicate that neither the method of preparation nor the method of analysis (unless part of the uranium is consistently lost in the chemical procedure) are the sources of error. Though visual estimates of the schroeckingerite content based on fluorescence are admittedly subject to error, it is believed that the discrepancies between estimates and assays are caused in part by the presence of fluorescent material other than schroeckingerite. (See under section headed Other uranium minerals.)

TABLE 12.—*Comparison of analyses (in percent) of six samples prepared by two different methods, Lost Creek schroeckingerite deposit, Red Desert, Wyo.*

No. of sample	Original analyses		Check test			
			Hand-prepared split		Laboratory-prepared split	
	Equivalent uranium	Uranium	Equivalent uranium	Uranium	Equivalent uranium	Uranium
DS–2–9	0.006	0.007	0.006	0.004	0.007	0.004
DS–2–10	.021	.049	.023	.047	.021	.044
DS–2–11	.005	.007	.005	.004	.005	.006
DS–5–80	.036	.063	.037	.081	.037	.080
DS–7–11i	.003	.001	.004	.000	.003	.000
DS–3–39	.007	.007	.007	.006	.006	.005

Schroeckingerite was identified under the petrographic microscope in sample DS–2–10. In some other samples, however, containing little or no uranium and from 0.1 to 5 percent of fluorescent material, little or no schroeckingerite was observed. For example, on the

basis of fluorescence, sample DS–10–157 from hole ES–10 was estimated to contain from 1 to 2 percent schroeckingerite. Therefore, theoretically, it should have contained from 0.27 percent to 0.54 percent uranium, but actually it assayed only 0.001 percent uranium. The fluorescent material in this and other similar samples, examined under the binocular microscope, fluoresces a slightly duller and more yellow color than does schroeckingerite (megascopic examination of the fine-grained material does not permit such fine color distinctions to be made) and is a very fine-grained aggregate with an index of refraction of less than 1.49; it is possibly allophane or opal. Some samples of this type contain very fine grains that are believed to have the true color of schroeckingerite in addition to the unknown material of lower refractive index.

Traces of fluorescent material which may be in part schroeckingerite were found at a maximum depth of about 34 feet in hole ES–13 and at various depths above the water table in all 13 auger holes. In trenches and pits schroeckingerite extends to a depth of at least 5 feet. The evidence obtained from the program of preliminary auger testing in 1950 suggests that schroeckingerite does not occur below the water table, and that schroeckingerite concentration in bodies of potential ore grade may not extend below a depth of about 8 feet.

Preliminary field mapping has indicated that rich concentrations of schroeckingerite in the shale are localized along some of the contacts between the shale and iron-stained sandstone. Iron-stained material was found as much as 35 feet beneath the water table. Data obtained from the auger drilling (table 11) and from investigations of the trenches suggest that the richest concentrations of schroeckingerite in the trenched area near holes ES–1, –2, –3, –5, and –6 are within 7.5 feet of the surface. It cannot be concluded from assays, however, that rich concentrations do not persist to greater depths, because schroeckingerite pellets are erratically distributed within beds both horizontally and down dip. This has been shown by surface mapping and also suggested by some of the auger-testing data. Hole ES–7 was drilled at a point determined by projection of an ore body from trench C_3 so that the ore would be intersected at a depth of about 10 feet. Samples in this hole, from depths of 5 to 12 feet, contain only 0.001 percent uranium (Auger hole ES–7, table 11). In the field about 5 percent of the samples of damp rock directly above the water table (12 feet) fluoresced, but when this material was dried, no fluorescent material was observed; apparently the fluorescence was caused by efflorescent salts that contain little or no uranium and which lost their ability to fluoresce upon drying. Hole ES–4 was so located that an ore body projected from trench L and pit 8 would be intersected at a depth between 10 and 15 feet. Samples from this hole

(table 11) contain 0.007 percent uranium in the interval between depths of 10 to 12 feet and 0.005 percent uranium in that between 12 to 14 feet, compared to a general content of 0.002 percent uranium in samples from the rest of the hole. A very thin concentration of schroeckingerite diluted by wall rock during drilling may cause the abnormal uranium content in the interval 10–12 feet.

The lack of significant amounts of schroeckingerite at depths which are above the water table and along projections of ore bodies may be attributed to (1) its sporadic distribution in each ore body—both horizontally and down dip, (2) the possibility that it does not occur below depths of 8 feet, (3) the possibility that favorable host beds either lens out or have been offset by faults, and (4) the possibility that schroeckingerite may be present in thin bodies that are insignificant in relation to the length of the sampled interval.

Radioactivity anomalies obtained from the gamma-ray logs of the auger holes (table 11), that do not correspond with the sample assays, such as the high radioactivity of the wall rock throughout hole ES–5, are not explained by existing data. It is possible that radon may cause some of the anomalies, or that imperfections of the instrument are to blame.

The uranium content of water samples (table 8) from 10 of the 13 auger holes ranged from 0.004 to 0.88 ppm. The analyses of water from holes ES–2, –3, –4, –5, and –6 indicate a fairly uniform abnormal uranium content in the ground water in the area near the trenches. Water from holes ES–7 and –10 contain, respectively, 0.50 and 0.88 ppm, but rock samples from neither of these holes contained more than 0.006 percent uranium—much less than the maximum uranium content of rock samples from holes ES–2, –3, and –5. The analyses of water from holes ES–8, –9, and –12 indicate that the ground water north of the fault zone contains relatively little uranium.

The limits of this near-surface uranium deposit are not known and will remain unknown until additional exploration is done. The gentle fold assumed to be in the vicinity of trench *L* and *K* (pl. 4) and the obscuring alluvial material along Lost Creek make it difficult to project positions of the beds which are the loci of ore bodies to the west side of Lost Creek.

Hole ES–7 cuts a sequence of interbedded sandstone, siltstone, and claystone and reached the water table at a depth of 12 feet. Although only one claystone bed was cut above the water table in this hole, many claystone beds were cut below the water table. These can be projected updip to positions above the water table in the area between holes 6 and 7, where it is possible that some may be schroeckingerite bearing. Additional auger-drilling or trenching, outlined on pl. 21, will be required to predict the total number of such loci for ore bodies in the deposit.

ORIGIN

A thorough understanding of the source of uranium and the processes involved in the formation of the Lost Creek deposit—the largest deposit of schroeckingerite now known in the world—would have wide application in the continuing study of other deposits of secondary uranium minerals. Although the final stages in the formation of schroeckingerite are reasonably clear, data available are insufficient to do more than indicate several possible sources for the uranium.

The final stage in the formation of schroeckingerite appears to be crystallization from alkaline ground- or surface-water solutions during evaporation of the water. The mineral must thus be deposited above the water table, near the surface. An arid or semiarid climate would thus seem to be a requirement for its accumulation, for under wet climatic conditions the mineral would tend to be flushed out of the area. The process of schroeckingerite deposition is thus conceived to differ from that of caliche deposition only in the quasi-stratigraphic control of the schroeckingerite. Another requirement for the formation of large pellets of the mineral appears to be a fine-grained host rock, such as shale of the Green River formation.

An experiment performed by Guillotte (unpublished report, 1945) bears on this problem. He pulverized specimens of shale containing large pellets of schroeckingerite, added water and thoroughly mixed the slurry until schroeckingerite completely dissolved. The mud, left undisturbed until it had dried out, contained large pellets of newly formed schroeckingerite resembling in all respects those in the original specimens.

The observation that large pellets of schroeckingerite form in claystone, shale, or siltstone, whereas only disseminated flakes or surface incrustations of schroeckingerite form in adjacent sandstone and on the ground surface, may be explained by the difference in the capacity of the different types of sediments to retain water. As the near-surface rocks dry out, the finer grained sediments retain water for a longer time than the coarser grained sandstone, or than any sediments at the ground surface, thus furnishing an environment in which the mineral could crystallize relatively slowly and form large pellets or aggregates of crystals. If this is so, then one might expect to find pellets of schroeckingerite even in sandstone near the permanent water table.

Other known factors entering into the problem of the genesis of the schroeckingerite deposit are its localization within the Cyclone Rim fault zone, and the relationship between solution zones of iron-stained sandstone and shale and schroeckingerite. Although the deposit has not been delimited, schroeckingerite is, with one exception, confined to the Cyclone Rim fault zone. The exception (the ore in exposure *B* and pit 1, pls. 19 and 21) might be explained by

faulting subsidiary to the major fault zone, although such subsidiary faulting has not been established. Although exposures are poor, it seems remarkable that schroeckingerite has not been found anywhere else in the Red Desert. It is probable, therefore, that the zone of faulting is a major control in the localization of the schroeckingerite deposit.

The close though not constant association of zones of iron-stained sandstone and shale and the ore bodies of schroeckingerite suggests that they may be related in genesis. However, the fact that not all iron-stained zones contain schroeckingerite may only mean that the uranium mineral formed in the same environment as did iron oxides. The iron oxides were probably formed by the oxidation of ferrous hydroxide derived from ground water. Ferrous hydroxide may have been derived from distant source beds, such as beds buried beneath the stained zones, and transported relatively long distances, or may have been derived from local source beds, such as the shale beds at the present sites of the stained zones, and transported laterally only a few inches or feet. The flow of ground water would tend to be localized in the permeable sandstone beds next to the relatively impermeable shale beds. On the other hand, water held in the shale would tend to migrate laterally into the adjacent sandstone as the level of the water table sank during dry seasons, for the sandstone would dry faster than the shale thus forcing the water held in the shale to migrate into the sandstone. Perhaps the relation in the iron content of samples closely spaced across an iron-stained zone, including both sandstone and shale and the adjacent mineralized shale bed might help resolve the problem of distant versus local source of the iron. Either postulation seems to require that the water table be low enough to permit air to enter the pore spaces of the sandstone beds. Present-day seasonal fluctuations of the water table permit the entrance of air only to a depth of about 20 feet. Therefore the iron-stained zones reached in auger-drilling at depths of as much as 35 feet beneath the water table probably were formed when the water table was much lower than it is now, possibly during dry interglacial stages of the Pleistocene epoch. The iron-stained zones that in places contain schroeckingerite beneath Recent colluvium, and beneath the Pleistocene terrace deposits are proof that iron oxides and schroeckingerite are still forming.

The source of the uranium carried by ground water remains problematical. Uraniferous lignite, however, is inferred to be the most likely source of the uranium for the following reasons:

1. Uranium apparently is leached from outcrops of uraniferous lignite near the area of the schroeckingerite deposit.
2. Uraniferous lignite, in which the uranium is in radioactive equilibrium, underlies the area south of the Cyclone Rim fault zone, as attested by the drill cuttings at the site of the California-Wyoming Development Co. oil well. The lignite, on the basis of geologic correlation (pls. 16 and 18), probably

is from 300 to 500 feet beneath the surface at the southwestern edge of the fault zone (cross section *B–B'*, pl. 19) and if present in the zone of faulting, would be closer to the surface and could be the local source of uranium in the schroeckingerite.

Uranium and iron thus may have been leached from the uraniferous lignite by ground water circulating to depths of a few hundred feet and thence carried upward in the porous rocks of the Cyclone Rim fault zone, to precipitate preferentially in beds of fine-grained sedimentary rocks above the low level of the ground-water table which prevailed during interglacial stages of the Pleistocene epoch. When the level of the ground-water table rose during glacial stages of the Pleistocene, and in Recent time, uranium was again dissolved, transported upward, and recrystallized as schroeckingerite. An equilibrium may exist, as schroeckingerite may be currently deposited from ground water at about the same rate that the mineral is dissolved and carried down Lost Creek by surface water. The iron-stained zones probably were first formed during the Pleistocene epoch. Once formed, the relatively insoluble iron oxide was not dissolved and transported by the later rise of the ground-water table, although new iron oxide probably is being deposited.

Some alternative theories that might explain the origin of the Lost Creek schroeckingerite deposit, or some features of it, are:

1. Uranium, derived from the surrounding crystalline basement rocks, accumulated in the Eocene Green River lakes and schroeckingerite crystallized in the near-shore muds as the lakes evaporated. This theory does not explain the localization of the Lost Creek deposit within the Cyclone Rim fault zone, nor the absence of other schroeckingerite deposits elsewhere in the general area where the Green River formation interfingers with Wasatch-type sedimentary rocks. Furthermore, it is difficult to understand, because the mineral is readily soluble, how there would now be any evidence left of an Eocene schroeckingerite deposit.
2. Uranium is leached by descending ground water from overlying source rocks, such as the Pleistocene terrace deposits, or the volcanic ash of the Continental Peak and Chadron formations of Nace's usage (Nace, 1939), carried laterally into the Cyclone Rim fault zone to move updip and form schroeckingerite on evaporation. This theory is plausible because of the widespread occurrence of radioactive rocks in the Red Desert, although it does not account for the localization of the Lost Creek deposit.
3. Uranium is leached from buried hydrothermal uraniferous vein deposits by ascending ground water and carried upward into the rocks of the Cyclone Rim fault zone. In other areas, such as in the Marysvale district, Utah, schroeckingerite is a secondary mineral, apparently derived from pitchblende. The occurrence of schroeckingerite in beidellite clays and the presence of the fluorine atom in the schroeckingerite molecule raise the possibility that, as in some other mining districts, beidellite and fluorite may be products of hydrothermal action. The theory is tenable, although no uraniferous veins are known to have been found in the area.

The available evidence, therefore, points toward the source of the uranium as buried beds of uraniferous lignite, although additional study and exploration will be required to establish the validity of any theory of the source of the uranium at the Lost Creek deposit.

AIDS TO PROSPECTING

Careful observation indicates that the Geiger-Mueller counter is of little value in detecting schroeckingerite if the mineral is covered

by even a thin mantle of overburden. The ultraviolet lamp is the most useful single tool to use in prospecting for schroeckingerite in the Red Desert area and if these instruments are used together, reasonably certain identification of pellets of the mineral may be made. Small disseminated flakes of schroeckingerite are not so readily identified, and may easily be mistaken for opal or other material. It was observed that wherever efflorescent salts coating the surface of the ground had a decidedly greenish-yellow color under ultraviolet light, schroeckingerite could be found nearby by digging shallow pits.

The localization of schroeckingerite in shale of the Green River formation within the Cyclone Rim fault zone suggests that prospecting should be guided by this geologic association. Shale beds, and shale-sandstone sequences of beds within the fault zone southeast and northwest of the deposit should be examined as well as similar beds in other fault zones in the general area; for example, those in the Monument Dry Lake (pl. 17) might also be worth prospecting. Schroeckingerite was found in pit 27 (pl. 19) at the southeast end of the area trenched in 1948, and in trench *P* at the northwestern edge of the area. The deposit, therefore, has not been delimited, and must extend farther both to the northwest and to the southeast.

FUTURE OUTLOOK

Very likely, more schroeckingerite will be discovered by further prospecting. The fact that schroeckingerite bodies are more or less continuous; the likelihood that the known limits of the deposit will be extended by more exploration; the fact that schroeckingerite is soluble in water; and the possibility that the mineral is constantly replenished by deposition from ground water, suggest that it might be possible to produce uranium from the Lost Creek deposit economically under present conditions. The deposit should be explored to its limits. At the time the present field work was completed, further exploration by the Geological Survey was planned to follow, in general, the lines of proposed trenches and auger holes shown on plate 6.

Beds of uraniferous lignite have a greater extent than the area shown on plate 2. The lignite beds crop out over much of the country east of that area, but the beds are folded and faulted, so that detailed mapping probably will be required to establish their location and relationships. Because of the general westward dip of the beds, the main lignite beds probably do not crop out much farther west than the west edge of the area. Some of the thin lignite seams may thicken to the west, however, and other beds may be found by subsequent mapping. North of High Point Ridge, the beds are covered by Pleistocene and Recent deposits. Accordingly, drilling or other subsurface methods would be required to prospect the country west and north of the area, and to obtain samples of unweathered lignite. Samples closely spaced across lignite beds of the principal lithologic

components (coal, carbonaceous shale, etc.), together with bulk samples of the entire bed should be taken for chemical analysis. Mapping and studies of lignite were being continued by the Geological Survey at the time the present field work was completed.

Lignite that may be stratigraphically equivalent to that in the Red Desert area may be exposed in the vicinity of the Leucite Hills, north of Rock Springs, Wyo. and the uppermost lignite beds in the Washakie Basin, south of Wamsutter, may be worth prospecting.

At present the possibility of commercial exploitation of the uraniferous lignite beds is uncertain. Future need for uranium and other trace metals and the potential heat energy of the lignite may, when suitable methods of extracting the metals are developed, result in the utilization of the uraniferous lignite in the Red Desert area.

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STRATIGRAPHIC SECTIONS

Stratigraphic section 1 (columnar section 1, pl. 18)

Description	*Thickness (feet)*	*Distance above base (feet)*
Siltstone, yellow, gypsiferous, clayey; ferruginous sand nodules	3.0	110
Claystone, varicolored (gray, yellow, maroon); uppermost 2 inches is maroon platy shale	1.5	107
Lignite and papery carbonaceous shale; lignite bed 2	1.0	105.5
Claystone, silty; weathers white	1.0	104.5
Sandstone, light-weathering, buff, micaceous, arkosic; the lowermost 2 feet is concretionary, gritty, and with no black minerals	10.0	103.5
Shale, poorly exposed, dark-green, hackly; weathers olive-gray to yellowish	5.5	93.5
Sandstone, poorly exposed, coarse, buff; grades upward into siltstone	11.0	88
Sandstone, silty, the uppermost 3 feet is clayey; weathers olive-gray to buff; large quartz, feldspar, and mica grains	10.0	77
Sandstone, yellow-buff to tan, lenticular, well-sorted; fine- to coarse-grained, flaggy and calcareous from 62 to 64 feet	12.0	67
Claystone, green, yellowish in uppermost foot	5.5	55
Sandstone, buff, silty, concretionary (may not be in place)	11.0	49.5
Claystone, olive to yellow, silty, blocky-weathering	1.0	38.5
Sandstone, buff, well-sorted to silty, semiconsolidated (resembles sandstone of the Tongue River member of the Fort Union formation in North Dakota)	7.5	37.5
Claystone, gray to black	5.5	30
Lignite, vitreous, blocky-weathering (lignite bed 1)	2.5	24.5
Sandstone, buff, clayey	4.5	22
Claystone, carbonaceous	1.0	17.5
Siltstone, olive-green, tan weathering	7.5	16.5
Sandstone, varicolored; claystone; and silty claystone	3.0	9
Sandstone, red, well-sorted, semiconsolidated, micaceous, brown-stained on surfaces	6.0	6

Stratigraphic section 2 (columnar section 2, pl. 18)

Description	Thickness (feet)	Distance above base (feet)
Sandstone, white to yellow, fine-grained, with ferruginous nodules; near the top the unit becomes more clayey, more yellow, and the nodules become thin lenses	14.0	80.0
Claystone, brown, sandy, highly gypsiferous	3.0	66.0
Shale, gray-brown, carbonaceous, platy, gypsiferous	3.0	63.0
Shale, light-gray, paper-thin in uppermost 0.5 foot, underlain by light-buff sandstone and platy siltstone above carbonaceous shale interbedded with lignite; fine-grained, light-brown sandstone at base	4.0	60.0
Sandstone, tan to red, platy; overlain by bed of maroon ash	4.5	56.0
Clinker, red, and ash, white (lignite bed 3)	2.0	51.5
Poorly exposed	2.5	49.5
Sandstone, coarse-grained, white, well-cemented	2.0	47.0
Poorly exposed (probably olive-gray, platy, claystone)	6.5	45.0
Poorly exposed (probably sandstone grading upward into platy siltstone)	3.5	38.5
Sandstone, flaggy, calcareous, medium-grained, current-bedded	2.0	35.0
Sandstone, fine-grained, gray, with carbonate specks; olive shale and cream-yellow weathering siltstone	5.5	33.0
Siltstone, cream-yellow; 0.5 foot of black to brown carbonaceous platy shale; siltstone; 1.5 feet of coarse gray sandstone at base	7.0	27.5
Siltstone, light-gray, weathers to a cream color; becomes sandy upward	4.0	20.5
Sandstone, arkosic, weathers to a cream color, and maroon carbonaceous shale; 2.0 feet of maroon, micaceous, platy, carbonaceous siltstone at base	7.5	16.5
Claystone, gray-brown, silty	3.5	9.0
Sandstone, gray to buff, calcareous, nodular, arkosic, micaceous, ferruginous	5.5	5.5

Stratigraphic section 3 (columnar section 3, pl. 18)

Sandstone, white, flaggy, calcareous, coarse-grained, micaceous, current bedded	6.5	38.5
Sandstone, platy, fine-grained, and interbedded platy to paper-thin carbonaceous shale; silty in upper part	9.5	32.0
Shale, light-brown, carbonaceous, and platy siltstone, with two thin beds of white sandstone	5.5	22.5
Lignite, black, platy, vitreous (lignite bed 3), overlying chocolate-brown paper-thin shale and white, fine-grained sandstone	6.0	17.0
Sandstone, white, coarse-grained, flaggy	1.0	11.0
Siltstone, yellow, sandy, interbedded with pale-green sandstone and claystone; cream-yellow, current-bedded sandstone at base	10.0	10.0

Stratigraphic section 4 (columnar section 4, pl. 18)

Description	Thickness (feet)	Distance above base (feet)	Radioactivity (scale divisions) 0.2 mr per hr*		
			Min	Max	Avg
Sandstone, calcareous, fossiliferous, (fossil locality F–8); fine- to medium-grained, arkosic, micaceous; white, silty below; yellow above; caps butte	12. 0	106	1 0 2	5 6 6	4 3 4
Shale, platy, sandy at top and base	10	94. 0	2	8	5
Sandstone, flaggy, calcareous, fossiliferous (fossil locality F–7); makes prominent ledge; fine- to coarse-grained	4	84. 0	0	5	2. 5
Sandstone, green; weathers buff; contains turtle plates and gar-pike scales; overlies blocky-weathering green shale; grades downward into white, micaceous fossiliferous sandstone (fossil locality F–6)	6. 0	80. 0	2	5	3
Sandstone, white, micaceous; some ledges of calcareous, fossiliferous sandstone, and subordinate carbonaceous platy shale, and buff sandy siltstone	24. 5	74. 0	1	7	4
Shale, paper-thin to platy; in part, chocolate-brown and with numerous plant fragments; in part silver-gray and with fish scales; contains 0.1- to 0.3-foot layers of silty, buff, fine-grained sandstone; becomes silty upward grading into silver to brown loess or siltstone in uppermost foot	16. 5	49. 5	1	7	4
Sandstone, white, flaggy, calcareous; fossiliferous; caps bench	2. 0	33. 0	0	4	2
Sandstone, coarse- to fine-grained, white to buff, ferruginous; interbedded with chocolate-brown platy shale	1. 0	31. 0			
Siltstone, sandy; zone of vertebrate fossils	1. 0	30. 0	2	8	5
Sandstone, buff to yellow, in part, calcareous, ferruginous, micaceous, and nodular; becomes silty toward top	18. 0	29. 0	3	7	5

*Radioactivity at the outcrop determined with standard survey Geiger-Mueller counter, beta-gamma, 0.2 mr per hr scale.

Stratigraphic section 4 (columnar section 4, pl. 18)—Continued

Description	Thickness (feet)	Distance above base (feet)	Radioactivity (scale divisions) 0.2 mr per hr*		
			Min	Max	Avg
Claystone, carbonaceous, paper-thin; in beds 0.3 foot thick; interbedded with olive-gray silty, paper-thin claystone	5. 5	11. 0	5	10	7
Siltstone, buff	1. 0	5. 5			
Shale, olive-gray, silty; blocky-weathering	3. 5	4. 5	2	8	4
Sandstone, white, calcareous	1. 0	1. 0	1	5	2. 5

*Radioactivity at the outcrop determined with standard survey Geiger-Mueller counter, beta-gamma, 0.2 mr per hr scale.

Stratigraphic section 5 (columnar section 5, pl. 18)

Description	Thickness (feet)	Distance above base (feet)
Sandstone, platy, tan, less silty at top of lowest 4.5 feet; overlain by 0.5 foot of flaggy, white, calcareous, medium-grained sandstone; overlain by 6.5 feet of buff, silty sandstone containing turtle plates, some limonite cement; capped by 0.5 foot of flaggy, sparsely fossiliferous calcareous sandstone	11. 5	54. 5
Siltstone, brown-green, ferruginous, sandy lenses; sandy at top	3. 0	43. 0
Shale, chocolate-brown, paper-thin	1. 5	40. 0
Sandstone, gray, flaggy, fossiliferous, calcareous, micaceous (fossiliferous locality F–9)	3. 0	38. 5
Shale, gray-brown, paper-thin	1. 0	35. 5
Sandstone, calcareous, silty	1. 0	34. 5
Sandstone, drab, thin-bedded, and gray, blocky-weathering silty claystone	1. 0	33. 5
Sandstone, gray, micaceous, clayey, with ferruginous bands; olive-green and more clayey near the top; many turtle bones and plates	10. 5	32. 5
Sandstone, buff to white, with ferruginous layers, poorly sorted, arkosic	11. 0	22. 0
Sandstone, yellow-buff, silty	3. 0	11. 0
Shale, chocolate-brown, carbonaceous, paper-thin	2. 5	8. 0
Sandstone, buff, grading downward into platy, gray shale	2. 5	5. 5
Sandstone, silver-gray, platy, and silty claystone	3. 0	3. 0

Stratigraphic section 6 (columnar section 6, pl. 18)

Sandstone; white to buff, flaggy, fossiliferous, calcareous (fossiliferous locality F–10)	11. 5	35. 5
Sandstone; fine-grained, buff-weathering, white to yellow, silty	10. 0	24. 0
Shale; platy to paper-thin, brown, carbonaceous	11. 0	14. 0
Sandstone; green-gray, calcareous, fossiliferous (ledge-former)	3. 0	3. 0

Stratigraphic section 7 (columnar section 7, pl. 18)

Description	Thickness (feet)	Distance above base (feet)
Sandstone, arkosic, salmon-pink, poorly sorted, coarse-grained, current-bedded (channel axes trend S. 75° W.), with some flaggy masses and white zones; a zone of log-shaped concretions in uppermost foot	15.5	101
Sandstone, white, fine-grained, micaceous in part calcareous; overlain by carbonaceous paper-thin shale	1.0	85.5
Sandstone, coarse, white-weathering, buff with sparse, poorly preserved fossils; red to orange in basal foot	5.5	84.5
Shale, silver-gray to olive-green, paper-thin	11.0	79.0
Poorly exposed, steep local flexure, offset(?)	5.5	68.0
Sandstone, white to light buff, flaggy, variable amounts of calcareous cement from bed to bed; basal 3 feet white, coarse-grained, arkosic	21.5	62.5
Shale, drab to olive-green, paper-thin, petroliferous and fossiliferous; 0.1-foot layers of buff, gypsiferous bentonite at 12.0 feet, 15.0 feet, 35.0 feet, and 36.0 feet. Ostracods and small pelecypods collected at 16.5 feet; (fossil locality JBR–2)	38.0	41.0
Sandstone, green or white calcareous with 0.5-foot bed of coquina at top; (fossiliferous locality F–11)	3.0	3.0

Stratigraphic section 8 (columnar section 8, pl. 18)

Description	Thickness (feet)	Distance above base (feet)
Poorly exposed, probably gray-brown, oolitic limestone, algal reef; this unit with the underlying unit forms cap rock of the land surface to the south and north	4.0	44.0
Limestone, sandy, and subordinate sandstone; the limestone is brown flaggy, and contains oolitic grains and pale gray-green clay galls; the sandstone is buff and flaggy	5.0	40.0
Oil shale, paper-thin, chocolate-brown to gray, interbedded with gray, calcareous, oolitic sandstone, becomes platy, more gray, and silty claystone in uppermost 3 feet; abundant ostracods; abundant vertebrate fossils (turtle plates and bones, gar-pike scales) from 33 feet to 35 feet	27.0	35.0
Siltstone, gray-brown	2.0	8.0
Sandstone, white, gray siltstone, silty sandstone, capped by 0.5-foot gray medium-grained sandstone (bench-former)	6.0	6.0

Stratigraphic section 9 (columnar section 9, pl. 18)

Description	Thickness (feet)	Distance above base (feet)
Not exposed. The base of the Chadron formation is within this interval	28	534.0
Sandstone, coarse-grained buff, and some mudstone; poorly exposed from 451 to 506 feet; sandstone has torrential current-bedding from 451 to 506 feet and contains pebbles of green chalcedony; fossil of large turtle at interval 439 feet to 441 feet	77.0	506.0
Conglomerate, gravel and boulder; unit caps and forms Cyclone Rim; poorly exposed; pebbles and boulders are predominantly brown to black chalcedony and white agate; subordinately granitic, volcanic, and metasedimentary rocks	71.5	429.0

Stratigraphic section 9 (columnar section 9, pl. 18)—Continued

Description	Thickness (feet)	Distance above base (feet)
Poorly exposed (probably blocky brown shale, sandstone containing vertebrate remains; also probably includes pale-yellow-green calcareous ash that was found 1 mile east)	102.0	357.5
Sandstone; the uppermost 8 feet is fine-grained, calcareous, salmon-colored, or brown; the lower part is micaceous, white, in part fossiliferous, calcareous and ledge-forming, in part unconsolidated, poorly exposed. This is the upper sandstone unit mapped (pl. 16)	41.0	255.5
Shale, brown to buff, paper-thin to platy	16.5	214.5
Sandstone, white to gray, arkosic, in part fossiliferous and calcareous. Fossil localities JBR–5, JBR–4, and JBR–3 at 196 to 195.0 feet, 183.0 to 185.0 feet, and 170 feet, respectively. This is the lower sandstone unit mapped (pl. 16)	26.5	198.0
Shale, gray to brown, paper-thin to platy; some ¼-inch beds of sandy limestone	10.0	171.5
Sandstone, calcareous, and sandy limestone	2.0	161.5
Claystone, gray, platy; interbedded with 1-foot beds of white to buff siltstone or sandstone in upper 11 feet; overlying olive-green, platy to paper-thin shale that grades upward into clayey siltstone	22.5	159.5
Sandstone, calcareous, platy, current-bedded; weathers white	2.0	137.0
Claystone, sandy and claystone; blocky-weathering, light-tan, gray-green, maroon, or buff; bentonitic in interval from 104.5 to 110.0 feet	34.0	135.0
Sand, fine-grained, in part cemented by calcite to form sandstone; sparsely fossiliferous	5.5	101.0
Sandstone, light gray-green, clayey	3.5	95.5
Limestone, clayey	3.0	92.0
Shale, olive-green, paper-thin	4.5	89.0
Limestone, fossiliferous, and 0.2 foot of paper-thin shale	2.5	84.5
Sandstone, fine-grained micaceous flesh-colored	6.2	82.0
Sandstone, white, ashy(?), fine-grained, highly gypsiferous; and oolitic limestone containing abundant ostracods; (section crosses fault striking N. 80° E., dipping steeply, stratigraphic displacement is 3 feet down on southwest side); overlies gray, paper-thin shale with abundant ostracods	3.5	75.8
Limestone, white, clayey, with concretions	0.3	72.3
Claystone olive-green, sandy	5.0	72.0
Siltstone, clayey, platy, gray-green (weathers light green); the basal foot is buff-yellow	10.0	67.0
Sandstone, arkosic, poorly sorted, buff, weathers white; varies in degree of cementation; the uppermost foot is a calcareous, ledge-forming micaceous sandstone that grades laterally into siltstone	11.0	57.0
Claystone and shale, poorly exposed; gray (weathers white), gypsiferous; more gypsiferous, gritty and lighter in color near top	17.5	46.0
Sandstone, poorly exposed, light-brown, silty	15.5	28.5
Conglomerate, brown, containing pebbles, boulders of granitic rocks, chert, feldspar, quartzite; weathers white	11.0	13.0
Shale, green, blocky, poorly exposed	2.0	2.0

ANALYSES

TABLE 3.—*Analyses of material other than lignite, carbonaceous shale, schroeckingerite, or water, Red Desert, Wyo.*

No. of sample	Locality of sample (pl. 16 unless otherwise noted)	Material of sample	Equivalent uranium (percent)	Uranium (percent)
DW-102 (S:294)	Center of Lost Creek Dry Lake.	Moist clay, about 1 foot beneath surface.	0.004	0.001
DW-112 (S:295)	do	Dry crust of mud and silt, about 3 inches beneath surface.	.003	.002
DW-108 (S:305)	Arapahoe Creek	Fluorescent, green, gypsiferous sandstone and claystone.	.005	.003
WNS-2 (S:2)	Bank of Lost Creek, 1 mile north of Hadsell shearing pens.	Green claystone	.006	.002
WNS-3 (S:4)	Chain Lake	Lakeshore mud (clay and silt).	.005	.002
WNS-6 (S:8)	Dry-lake bed (pl. 17)	Clay	.008	.001
WNS-8 (S:10)	1.5 miles northeast of Hadsell shearing pens.	Surface gravel and soil	.005	.001
WNS-9 (S:11)	Trench *J*, Lost Creek schroeckingerite deposit.	Pleistocene terrace gravel	.005	.002
WNS-12 (S:17)	Lake bed 2 miles east of Eagles Nest.	Clay and sandy clay	.003	.002
WNS-15 (S:20)	Monument Dry Lake (pl. 17)	Clay	.003	.002
WNS-17 (S:24)	In sump of water well at site of Californian-Wyoming Development Co. oil well.	Gray and brown clay with specks of lignite.	.007	.004
WNS-19 (S:27)	Antelope Hills, about 20 miles northwest of Hadsell shearing pens.	Gabbro dike intruding granite	.000	.001
WNS-20 (S:28)	Bank of Lost Creek, 1½ miles north of Hadsell shearing pens.	Fluorescent, gypsiferous, silty, claystone and sandstone.	.004	.002
WNS-23 (S:31)	Soda Lake	Salt incrustation (alunogen, halite, and gypsum).	.001	.001
WNS-24 (S:32)	A wide area northwest of the Lost Creek schroeckingerite deposit.	Selected pebbles of fluorescent agate-chalcedony.	.010	.006
WNS-25-33	Trench K_3 (pl. 21), Lost Creek schroeckingerite deposit.	Volcanic ash (dolomitic calcite and volcanic glass).	.025	.011

TABLE 4.—*Analyses of water samples (in parts per million), Red Desert, Wyo. (Does not include samples taken from auger holes in 1950)*

No. of sample	Locality of sample (pl. 16)	Uranium	HCO_3^-	CO_3^{--}	SO_4^{--}	Cl^-	Total solids
DW-102 (S:296)	Pond at mouth of Lost Creek	0.00	70	2	103	19	-------
DW-85 (S:264)	Spring at mouth of Osborne Draw. (Sampled May 5, 1949.)	.44	83	7	127	20	-------
WNS-10 (S:14)	Spring at mouth of Osborne Draw. (Sampled July 29, 1949.)	.01	136	6	78	20	294
WNS-22 (S:30)	Spring at Osborne Draw. (Sampled October 6, 1949.)	.13	-------	-------	-------	-------	110
DW-85 (S:265)	Lost Creek below bridge at schroeckingerite deposit.	.00	114	17	54	5	-------
WNS-3 (S:3)	Chain Lake (muddy water)	.03	2,147	242	1,956	1,960	8,290
WNS-7 (S:9)	Sourdough Dam 1. Reservoir in part on lignite bed 1.	.01	102	0	28	68	173
WNS-9 (S:13)	Pit 14, Lost Creek schroeckingerite deposit.	46.00	486	34	6,590	40	14,120
WNS-17 (S:25)	Water well 3; site of California-Wyoming Development Co. oil well.	.03	-------	-------	-------	-------	640
WNS-21 (S:29)	P. B. Spring, Antelope Hills, 23 miles northwest of Hadsell shearing pens (not shown on pl. 16).	.01	-------	-------	-------	-------	200

TABLE 5.—*Spectrographic analysis (in percent) of samples of uraniferous lignite, Red Desert, Wyo.*

[Paul R. Barnett, U.S. Geological Survey, analyst]

No. of sample (locality on pl. 17)	Lignite bed	Material of sample	Uranium in ash	Cu	Pb	Co	Ni	Zn	Zr
DW-103 (S:297)	1	Lignite	0.019	0.00X	(1)	0.001	0.003	(1)	(1)
DW-103 (S:298)	1	Carbonaceous shale	.004	.00X	0.00X	.001	.002	0.X	0.00X
DW-103 (S:299)	1	Shale and lignite	.008	.00X	.0X	.001	.003	.X	.00X
WNS-1 (S:1)	1	Lignite and carbonaceous shale.	.022						
WNS-4 (S:5)	2	Lignite and shale	.008	.00X	.00X	.000X	.001		
WNS-4 (S:6)	2	Lignite	.015	.00X	.0X		.001		.00X
WNS-5 (S:7)	2	Lignite and carbonaceous shale.	.011	.00X			.001		

No. of sample	Ti	Mn	V	Cr	Y	Be	Mo	Sc	Ba
DW-103 (S:297)	0.0X	0.0X	0.00X	0.00X	0.00X	Tr.	0.00X	0.000X	0.00X
DW-103 (S:298)	.X	.0X	.0X	.00X	.00X	Tr.	.00X	.00X	.0X
DW-103 (S:299)	.X	.0X	.0X	.00X	.00X	Tr.	.00X	.00X	.0X
WNS-1 (S:1)									
WNS-4 (S:5)	.0X	.00X	.0X	.00X	.000X		.00X	.00X	.0X
WNS-4 (S:6)	.X	.00X	.0X	.00X	.00X	Tr.	.00X	.00X	.X
WNS-5 (S:7)	.0X	.0X	.0X	.00X	.000X		.000X	.000X	.0X

No. of sample	Sr	Ca	Ce	La	Fe	Mg	B	Ga	Si
DW-103 (S:297)	0.00X	0.X	0.0X	0.0X	0.X	0.X	0.0X	0.000X	0.X
DW-103 (S:298)	.00X	.X	.0X	.0X	X	X	.0X	.00X	X
DW-103 (S:299)	.00X	.X	.0X	.0X	X	.X	.0X	.00X	X
WNS-1 (S:1)					X	.X	.X		X
WNS-4 (S:5)	.00X	.X	.0X	.00X	X	.0X	.0X	.000X	X
WNS-4 (S:6)	.00X	.X	.0X	.0X	X	.0X	.0X	.00X	X
WNS-5 (S:7)	.00X	.X	.0X	.00X	.0X	.0X	.0X		X

Looked for but not found: As, Tl, In, Ge, Re, Sn, Nd, Ta, U, Nb, Pt, W, Bi, Sb, Cd, Au, Ag.
[1] Looked for but not found.

TABLE 6.—*Analyses (in percent) of radioactive lignite, carbonaceous shale, clinker, and ash, Red Desert, Wyo.*

No. of sample (locality on pl. 17)	Thickness of sample interval (feet)	Type of sample	Lignite bed and material of sample	Equivalent uranium	Uranium	Ash	Uranium in ash
Lignite and carbonaceous shale (map symbol—●)							
WNS-1 (S:1)	12	Composite grab sample	Bed 1, lignite and carbonaceous shale.	0.010	0.007	38.7	0.022
DW-103 (S:297)	0.7	Composite chip sample	Bed 1, lignite	.007	.003	24.1	.019
DW-103 (S:298)	3.3	do	Bed 1, carbonaceous shale.	.008	.003	85.7	.004
DW-103 (S:299)	2.0	do	Bed 1, carbonaceous shale, with thin lignite seams.	.010	.004	69.1	.008
WNS-4 (S:5)	15-20	do	Bed 2, lignite and carbonaceous shale.	.015	.003	74.7	.008
WNS-4 (S:6)		Grab sample	Bed 2, lignite only	.005	.003	32.2	.015
WNS-5 (S:7)	10	Chip sample	Bed 2, lignite and carbonaceous shale.	.003	.003	26.0	.011
WNS-11 (S:15)	10	do	Bed 2(?), lignite and carbonaceous shale.	.004	.003		
WNS-13 (S:18)	6	do	Bed 3, lignite	.002	.002	9.1	.015
Clinker and ash (map symbol—▲)							
WNS-1 (S:12)		Grab sample	Bed 1, clinker, ash, baked clay.	0.014	0.005		
WNS-11 (S:16)	3	Composite of 10 feet.	Bed 1 or 2, clinker	.007	.003		
WNS-16 (S:21)		Grab sample	Bed 1, clinker	.007	.003		
WNS-16 (S:22)	3	Chip sample	Bed 1, ash	.013	.006		
WNS-14 (S:19)	3	do	Bed 3, clinker and ash	.012	.005		

TABLE 7.—*Analyses of rock samples, Lost Creek schroeckingerite deposit, Red Desert, Wyo.*

[The prefix ME to the sample number indicates the sample was taken by the Minerals Engineering Co., in 1948 and analyzed by the Brown Engineering Co., Grand Junction, Colo.; the prefix TW indicates the sample was taken by C. C. Towle and D. G. Wyant in 1949 and analyzed by the U. S. Geological Survey. Equivalent uranium was determined by reference to a standard uranium sample in which the uranium is in equilibrium with all its decomposition products. Corrected equivalent uranium was determined by reference to a standard uranium sample in which the uranium is in equilibrium with UX_1 (Thorium 234) and UX_2 (Protoactinium 234) only.]

No. of sample	Locality of sample (pl. 21)	Material of sample	Dimensions of sample		Equivalent uranium (percent)	Corrected equivalent uranium (percent)	Uranium (percent)
			Length (ft)	Thickness (ft)			
ME-1925	Trench *A*		5	0.67			0.11
ME-1927	do		2.5	.25			.19
TW-30	do	Clayey conglomerate, claystone, sparse schroeckingerite, efflorescent white salts.		1.7	0.041	0.066	.055
ME-1936	do		8	1			.10
ME-1935	do		4	.5			.02
TW-33	Trench *B*	Gravel, no schroeckingerite	5		.005	.008	.005
ME-1938	Trench *C*		5	.83			.05
ME-1939	do		16	.5			.19
ME-1929	do		6	.8			.14
ME-1931	do		5	.5			.06
TW-35		Claystone and schroeckingerite.		.5	.15	.24	.21
ME-1930	Trench *D*		5	.5			.13
ME-1919	do		30	.75			.15
TW-28	do	Claystone and schroeckingerite.		1.3	.082	.13	.11
ME-1923	do	(Lower bed)	4	.3			.11
ME-1921	do		20	1			.10
TW-23	Trench *E*	Claystone, schroeckingerite, and efflorescent white salts.		1	.018	.029	.024
ME-1934	Trench *E'*		12	.83			.13
TW-24	do	Claystone and schroeckingerite.		1.3	.020	.032	.022
ME-1933	do		12	.83			.08
ME-1941	Trench *F*		4	.5			.07
TW-22	do	Claystone, sandstone, and sparse schroeckingerite.		1.5	.048	.077	.054
ME-1940	do		8	.82			.18
TW-21	do	Green claystone and schroeckingerite.		1	.070	.11	.095
ME-1952	Trench *G*		12	.83			.17
TW-20	do	Green claystone and schroeckingerite.		.8	.067	.11	.10
TW-18	Trench *H*	Claystone, sandstone, and gravel (Qt_3) (includes 0.8 foot of claystone and schroeckingerite).		4	.054	.086	.075
TW-15	Trench *I*	Terrace material (Qt_2) and clay; no schroeckingerite.		4.5	.004	.006	.004
TW-17	do	Green claystone and gravelly claystone; includes 1 foot of claystone and schroeckingerite.		3	.11	.18	.14
TW-14	do	Green clay and white salt, terrace material (Qt_3); no schroeckingerite.		3.5	.005	.008	.004
TW-13	do	Terrace material (Qt_3); no schroeckingerite.		4	.007	.011	.006
TW-10	Trench *J*	do		4.5	.004	.006	.002
TW-11	do	Terrace material (Qt_2) trace schroeckingerite.		5	.009	.014	.010
TW-6	Trench *K*	Composite sample, terrace material, (Qt_3) and clay.		4.5	.007	.011	0.004
ME-1948	do		25	1			.11
TW-5	do	Green siltstone, schroeckingerite.		.5	.37	.059	.053
ME-1945	do		14	.75			.14
ME-1946	do		35	.42			.14
TW-7A	do	Colluvial gravel (Qcl)		1.3	.004	.006	.002
TW-7B	do	Green claystone, sandstone		.5	.058	.093	.091
TW-8	Trench K_1	Green claystone, sparse schroeckingerite.		.8	.029	.046	.046
ME-1943	Trench K_2		?	1.0			.13
TW-9	do	Terrace material (Qt_3) and some clay.		4.0	.007	.011	.008

TABLE 7.—*Analyses of rock samples, Lost Creek schroeckingerite deposit, Red Desert, Wyo.*—Continued

No. of sample	Locality of sample (pl. 21)	Material of sample	Dimensions of sample		Equivalent uranium (percent)	Corrected equivalent uranium (percent)	Uranium (percent)
			Length (ft)	Thickness (ft)			
ME-1909	Trench K_3						0.08
ME-1950	Trench L		27	0.75			.09
TW-4	do	Sandy green claystone with schroeckingerite.		.8	0.081	0.13	.11
TW-3	do	Green claystone with schroeckingerite.		.5	.041	.066	.064
TW-39	Trench M	Green claystone with schroeckingerite.		.8	.070	.11	.091
TW-1	Lost Creek bluff.	Claystone and schroeckingerite.		1	.015	.024	.013
TW-2	do	Sandstone, claystone; no schroeckingerite.		1.3	.006	.010	.009
ME-1906	Pit 27						.13
TW-32	do	Claystone and sparse schroeckingerite.		.7	.039	.062	.049
TW-34	Hole 39	Terrace material		1.3	.005	.008	.004
TW-31	Pit 23	Clayey conglomerate, claystone, salts, and sparse schroeckingerite.		1	.015	.024	.022
TW-29	Pit 24	Green claystone and schroeckingerite.		.8	.050	.080	.055
ME-1905	do						.14
ME-1901	Pit 18 (north side).						.20
ME-1902	Pit 18 (south side).						.14
ME-1903	do						.03
TW-27	do	Claystone, some sandstone with schroeckingerite.		1.3	.041	.066	.063
TW-36	Pit 18	Grab sample of ore pile from pit.			.046	.074	.065
ME-1907	Pit 21						.04
TW-26	Pit 20	Claystone and schroeckingerite.		1.5	.12	.19	.14
ME-1904	Pit 19						.09
TW-25	do	Claystone and schroeckingerite.		.8	.14	.22	.17
ME-1908	Hole 38						.03
TW-19	do	Green claystone with schroeckingerite.		1	.097	.16	.15
ME-1917	Pit 16 (west side).						.28
TW-16	Pit 16	Terrace material (Qt_3) and 1 foot clay.		3	.008	.013	.008
ME-1918	Pit 16 (east side).						.14
TW-12A	Pit 14 (north side).	Green siltstone with schroeckingerite.		1.3	.034	.054	.048
ME-1913	Pit 14 (south side).						.24
TW-12B	do	Claystone, no schroeckingerite.		.8	.007	.011	.004
ME-1910	Pit 8						.08
ME-1911	Pit 4						.11
TW-38	do	Claystone, sparse schroeckingerite.		.8	.038	.061	.058
ME-1914	Pit 2						.04
TW-37	do	Claystone, white salts, sparse schroeckingerite.		.5	.016	.026	.018
ME-1916	Pit 1						.08

TABLE 8.—*Analyses (in parts per million) of surface- or ground-water samples, Lost Creek schroeckingerite deposit, Red Desert, Wyo.*

No. of sample	Locality of sample (pl. 21)	Date of sampling	U	CO_3^{--}	HCO_3^-	SO_4^{--}	Cl-	Total solids	U[1] in sludge	pH
DW-85-264	Spring at mouth of Osborne Draw.	May 5, 1949	0.44	7	83	127	20	------	------	----
WNS-10-14	----do----------	July 29, 1949	.01	6	136	78	20	294	------	----
WNS-22-30	----do----------	Oct. 6, 1949	.13	------	------	------	------	110	------	----
DW-85-265	Lost Creek below bridge.	1949	.00	17	114	54	5	------	------	----
WNS-9-13	Pit 14----------	1949	46.00	34	486	6,590	40	14,120	------	----
DS-2-199	Auger-hole ES-2	1950	.66	11.1	144.2	998.0	22.6	------	[2]	7.85
DS-3-200	Auger-hole ES-3	1950	.42	18.5	190.3	932.0	30.8	------	[2]	8.35
DS-4-201	Auger-hole ES-4	1950	.60	18.5	134.0	2,035.0	31.2	------	[2]	8.00
DS-5-202	Auger-hole ES-5	1950	.48	6.6	162.1	893.4	16.4	------	[2]	8.00
DS-6-203	Auger-hole ES-6	1950	.48	8.7	135.9	800.0	15.2	------	[2]	8.20
DS-7-204	Auger-hole ES-7	1950	.50	10.0	123.8	184.4	28.7	------	[2]	7.90
DS-8-205	Auger-hole ES-8	1950	.14	10.6	126.0	751.0	19.5	------	[2]	8.00
DS-9-206	Auger-hole ES-9	1950	.04	7.4	134.5	823.0	19.9	------	20.0	7.90
DS-10-207	Auger-hole ES-10	1950	.88	9.2	138.0	6,521.0	78.3	------	30.0	8.10
DS-12-208	Auger-hole ES-12	1950	.07	14.5	100.5	2,566.0	35.9	------	20.0	8.00

[1] Based on dried weight of sludge.
[2] Insufficient sludge for analysis.

TABLE 9.—*Analyses (in parts per million) of plant and soil samples, Lost Creek schroeckingerite deposit, Red Desert, Wyo.*

[Analyst, Helen Cannon]

Locality of sample (pl. 21)	No. of sample	Material of sample	Uranium	Vanadium oxide (V_2O_5)
Spring at mouth of Osborne draw.	P 1a------	Water plant, unidentified, dried----------	28	80
Do----------	P 1b------	Water plant, unidentified, wet, as collected--	36	40
Do----------	P 2-------	Sedge (*Eleocharis palustris*)----------	1.7	00
Do----------	P 3-------	Algae----------	39	500
Do----------	S 1-------	Black muck from spring bottom----------	10	40
Outcrop (*d*)----------	P 3a------	Greasewood (*Sarcobatus vermiculatus*) tops---	14	00
Do----------	P 4-------	Greasewood (*Sarcobatus vermiculatus*) roots in schroeckingerite-bearing clay.	7,400	400
Do----------	S 2-------	Soil at base of plant at depth of 1 foot------	270	100

AUGER-HOLE DATA

TABLE 10.—*Lithology of cuttings from shallow auger holes drilled by the U. S. Geological Survey in 1949, Lost Creek schroeckingerite deposit, Red Desert, Wyo.*

Reference no. (pl. 19)	Description	Depth in feet	Remarks
H-1	Gravel and white sand	0–1.3	Terrace deposit.
	Claystone, gray-green, silty, gypsiferous	1.3–3.0	
	Claystone, gray-green, silty	3.0–5.0	
	Claystone, siltstone, and green to buff sandstone.	5.0–6.0	Radioactivity: 2 scale divisions (milliroentgens per hr) above background which averages 2.5 scale divisions.
H-2	Gravel	0–0.5	Terrace deposit.
	Claystone, gray to brown, sandy	0.5–1.3	
	Claystone, green; contains schroeckingerite and gypsum.	1.3–2.3	Radioactivity: 32 scale divisions above background.
H-26	Sandstone, clayey sand and gravel	0–2.0	Terrace deposit(?), colluvium(?).
	Claystone, sandy	2.0–3.0	
	Claystone, platy, purple	3.0–4.0	No schroeckingerite.
	Sandstone, white	4.0–4.5	
H-27	Clay, purple, silty	0–1.0	
	Sandstone, white, coarse	1.0–2.0	
	Claystone, purple to green, silty	2.0–3.5	Iron-stained zone at 3.3 feet.
	Claystone, gray-green, silty	3.5–4.5	
	Claystone, buff to gray, plastic	4.5–4.8	
	Claystone, gray to brown, containing schroeckingerite siltstone.	4.8–5.2	
	Claystone, gray, blocky, silty	5.2–5.6	
H-28	Clay, gray and green	0–2.0	
	Sandstone, gypsiferous, orange	2.0–2.5	No schroeckingerite.
	Claystone, gray, silty, and gray claystone	2.5–3.0	
H-30	Gravel and green, white, and buff sand	0–9.7	Terrace deposit(?).
	Sandstone, mottled, argillaceous	9.7–10.2	
	Claystone	10.2–10.5	
	Siltstone, green, or fine sand	10.5–11.2	
	Sandstone, green to olive-brown	11.2–13.4	
	Siltstone, gray-green, and flakes and pellets of gray platy shale.	13.4–16.0	Shale is the ore-bearing bed in trench *F*. No schroeckingerite.
H-32	Trench fill	0–4.0	
	Siltstone, green, clayey, and some sandstone.	4.0–6.1	
	Claystone, gray	6.1–7.4	Platy shale fragments at 6.8 feet.
	Claystone, purple	7.4–7.6	Radioactivity: average of 10 scale divisions above background.
	Sandstone, brown to buff	7.6–8.0	Solution zone. Radioactivity: 5 scale divisions above background. No schroeckingerite.

TABLE 11.—*Lithology, content of uranium and equivalent uranium, and radioactivity of rocks entered by auger holes ES-1–ES-13 (pl. 21), drilled by the U. S. Geological Survey in 1950, Lost Creek schroeckingerite deposit, Red Desert, Wyo.*

[Radioactivity: samples, determined in the field with standard survey Geiger-Mueller counter, beta-gamma shield open and read on 0.2 milliroentgen-per-hour scale, background minimum—1, maximum—4, average—2.5 scale divisions; wall rock, determined with the same Geiger-Mueller counter equipped with a 2-foot gamma probe and read on 2-milliroentgen-per-hour scale except for some parts of wall rock in holes ES-3, ES-5, and ES-6, where star (*) indicates 20-milliroentgen-per-hour scale was used; background at surface of hole, minimum—5, maximum—11, average—8 scale divisions.]

Sample No.	Lithology (sample log)	Field radioactivity								Equivalent uranium in sample (percent)	Uranium in sample (percent)
		Samples				Wall rock					
		Depth (ft)	Scale divisions—0.2 mr per hr			Depth (ft)	Scale divisions—2.0 mr per hr				
			Min	Max	Avg		Min	Max	Avg		
Auger-hole ES-1											
DS-1- 1	Sand, brown	0–2				0.9				0.006	0.005
2	Claystone, gray-green sandy; more than 10 percent fluorescent material (including schroeckingerite).	2–3	7	12	10					.028	.059
3	Sandstone, brown clayey, 3–4 feet; green clayey arkose, 4–4.5 feet; more than 10 percent fluorescent material (including schroeckingerite).	3–4.5	5	12	8					.018	.033
4	Siltstone, green, 4.5–5.5 feet; brown platy shale, 5.5–6 feet.	4.5–6	1	6	3					.005	.005
5	Sandstone, green; less 1 percent fluorescent material.	6–7.5	1	6	3					.004	.003
6	Shale, brown platy; less than 1 percent fluorescent material.	7.5–8	1	7	3					.005	.003
7	do	8–9	1	6	3.5					.005	.003
	End of hole.										

TABLE 11.—*Lithology, content of uranium and equivalent uranium, and radioactivity of rocks entered by auger holes ES-1–ES-13 (pl. 21), drilled by the U. S. Geological Survey in 1950, Lost Creek schroeckingerite deposit, Red Desert, Wyo.*—Continued

Sample No.	Lithology (sample log)	Field radioactivity								Equivalent uranium in sample (percent)	Uranium in sample (percent)
		Samples				Wall rock					
		Depth (ft)	Scale divisions—0.2 mr per hr			Depth (ft)	Scale divisions—2.0 mr per hr				
			Min	Max	Avg		Min	Max	Avg		
Auger-hole ES-2											
DS-2- 8	Sand, brown; less than 0.01 percent fluorescent material (including schroeckingerite).	0–2	1	8	3	0–2	14	19	17	0.007	0.008
9	Sandstone, gray-green clayey; 1 percent fluorescent material (including schroeckingerite).	2–3	0	8	3	2–4	15	18	16.5	.006	.007
10	Sandstone, brown clayey; 1.25 percent fluorescent material (including schroeckingerite in pellets from 1/16- to 1/4-inch in diameter).	3–4	5	10	7					.021	.049
11	Sandstone, gray-green silty; 0.03 percent fluorescent material (including schroeckingerite).	4–5.5	0	7	3.5	4–6	11.5	15	12.5	.005	.007
12	Sandstone, gray-green arkosic; less than 0.02 percent fluorescent material.	5.5–6	0	5	1.5					.004	.004
13	Siltstone, green-gray clayey; with subordinate sandstone, 6–6.7 feet; brown claystone, 6.7–7 feet; less than 0.02 percent fluorescent material.	6–7	1	8	3					.006	.004
14	Claystone, green-gray sandy, 7–7.4 feet; green-gray clayey siltstone, 7.4–7.8 feet; gray sandy claystone, 7.8–8 feet; traces of fluorescent material.	7–8	1	7	2.5	6–8	16	19.5	18	.006	.005
15	Siltstone, gray clayey; traces of fluorescent material.	8–9	0	7	3					.005	.003
16	Siltstone, gray-green clayey; trace of fluorescent material.	9–10	0.5	6	2.5					.005	.003
17	Siltstone, green-gray clayey, 10–10.8 feet; brown-green claystone, 10.8–11 feet.	10–11	1	5	3	10–12	14	17.5	16	.005	.003
18	Siltstone, gray-brown clayey, 11–11.8 feet; gray clayey siltstone, 11.8–12 feet.	11–12	0	7	3					.004	.003
19	Siltstone, gray-green clayey, with a little sandstone.	12–13	0	5	2.5	12–14	12.5	16	14.5	.004	.003

20	Claystone, green-gray silty; water table at 14 feet.	13–15	0	5	2	14–16	11	16	14	.004	.003
21	Claystone, green-gray sandy, 15–16 feet; green-gray silty claystone, 16–17 feet.	15–17				16–18	13	18	15.5	.004	.004
22	Claystone, gray-green silty, with thin red-brown layer (stained by iron oxides) at 18.5 feet; brown sandstone at 19 feet.	17–19				18–20	12	16	14	.005	.004
23	Siltstone, red-brown, 19–20 feet; gray-green clayey sandstone, 20–21 feet.	19–21				20–22	11.5	15	13.5	.004	.003
24	Sandstone, gray-green clayey, 21–22.5 feet; red-brown siltstone 22.5–23 feet.	21–23				22–24	12.5	17	14	.005	.002
25	Sandstone, gray pebbly	23–25				24–26	10.5	14.5	12.5	.004	.003
26	Sandstone, gray pebbly, 25–27.5 feet; brown claystone 27.5–28 feet.	25–28				26–28	10.5	14.5	12.5	.004	.003
27	Sandstone, gray-green silty	28–29				28–30	12	15.5	13.5	.005	.005
28	Sandstone, gray-green silty, 29–31 feet; gray-green silty pebbly sandstone with a little green clay, 31–33 feet.	29–33				30–32	12	15.5	13.5	.003	.002
29	Claystone, brown silty, 33–34 feet, gray-green sandy claystone, 34–36 feet; brown claystone, 36–38 feet.	33–38				34–36 36–38	11 11.5	15.5 14.5	13 13	.005	.003
30	Claystone, green-gray	38–39				38–40	11.5	16	14	.007	.007
31	Claystone, green-gray (Caved at 40 feet.)	39–41								.004	.004
32	Claystone, green-gray, 41–41.5 feet; coarse white sandstone, 41.5–42.5 feet, brown-gray carbonaceous(?), 42.5–43 feet.	41–43								.004	.003
33	Caved rock (gray-green clay, brown carbonaceous(?) clay, and a little sand).	41.5–43								.005	.005
34	Sandstone, brown-white	43–49								.004	.003
35	Claystone, brown sandy (iron-stained), 49–49.2 feet; gray to brown sandy claystone, 49.2–50.8 feet; brown-white sandstone, 50.8–51 feet.	49–51								.004	.003
	End of hole	51									

Auger-hole ES–3

DS–3–36	Sand, gray-green, 0–1 foot; brown sandy claystone, 1–2 feet; less than 0.01 percent fluorescent material (including schroeckingerite).	0–2	1	7	3.5	0–2	13	17	15	0.006	0.010
37	Claystone, brown sandy, 2–2.5 feet; gray-green clayey sandstone, 2.5–3 feet; less than 0.01 percent fluorescent material (including schroeckingerite).	2–3	2	11	5	2–4	11	15	13.5	.010	.019
38	Sandstone, gray-green, silty, pebbly; pebbles as much as ¼ inch across; 0.01 percent fluorescent material (including schroeckingerite).	3–4	0.5	6	2.5					.006	.011
39	Sandstone, gray-green silty pebbly, with minor amounts of brown silt; 0.5 percent fluorescent material (including schroeckingerite).	4–6	1	11	5	4–6	15	19	17	.007	.007

TABLE 11.—*Lithology, content of uranium and equivalent uranium, and radioactivity of rocks entered by auger holes ES-1–ES-13 (pl. 21), drilled by the U. S. Geological Survey in 1950, Lost Creek schroeckingerite deposit, Red Desert, Wyo.*—Continued

Sample No.	Lithology (sample log)	Field radioactivity								Equivalent uranium in sample (percent)	Uranium in sample (percent)
		Samples				Wall rock					
		Depth (ft)	Scale divisions—0.2 mr per hr			Depth (ft)	Scale divisions—2.0 mr per hr				
			Min	Max	Avg		Min	Max	Avg		
Auger-hole ES-3—Continued											
DS-3- 40	Sandstone, gray-green, clayey silty 6–7.5 feet; brown clayey sandstone, 7.5–8 feet; less than 0.01 percent fluorescent material.	6–8	1	7	3.5	6–8	10	14	12.5	0.004	0.002
41	Sandstone, brown clayey, 8–8.5 feet; gray-green claystone, 8.5–9 feet; 0.01 percent fluorescent material.	8–9	1.5	6	3	8–10	15	18.5	16.5	.004	.003
42	Claystone, gray-green silty, (in part platy) with some sandstone; 0.01 percent fluorescent material.	9–11	1.5	7	3.5	10–12	*6.5	*8	*7.2	.005	.004
43	Claystone, gray-green silty, 11–11.3 feet; brown claystone and white sandstone, 11.3–12 feet; 0.01 percent fluorescent material.	11–12	1	9	4					.007	.006
44	Claystone, brown sandy and intermixed gray-green sandy claystone; 0.01 percent fluorescent material; (water table at 14 feet).	12–14	1	7	3.5	12–14	*5	*6.8	*5.5	.005	.002
45	Claystone, brown to gray-green sandy	14–15				14–16	*5	*7	*6.8	.007	.002
46	Sandstone, gray-green clayey 15–17.5 feet; brown sandy claystone, 17.5–18 feet; gray-green, clayey silty sandstone, 18–19 feet (Caved at 18 feet).	15–19				16–18	*4.5	*6	*5.2	.004	.001
47	Caved rock, 17.5–19 feet	17.5–19								.005	.002
48	Siltstone, gray-green sandy with a little brown-gray sandy siltstone, intermixed, 21–23 feet.	19–23								.005	.002
49	Claystone, gray-green sandy, 23–24 feet; blue-green-gray sandy claystone with a few yellow-brown iron-stains, 24–25 feet.	23–25								.004	.003
	End of hole	25									

Auger-hole ES-4

DS-4- 50	Sand, brown pebbly coarse	0-2	0	7	3.5	0.2	10	14	12.5	0.004	0.001
51	Sandstone, buff white silty with a little gray-green claystone; traces of fluorescent material.	2-4	0.5	6	3	2-4	10	13	11.5	.004	.003
52	Sandstone, brown-buff silty fine	4-4.5	0	7	3.5	4-6	7	10	8.5	.004	.002
53	Sandstone, white to slightly gray-green fine, with a small amount of coarse sandstone, 4.5-5.8 feet; brown siltstone, 5.8-6 feet.	4.5-6	1	7	3					.004	.002
54	Sandstone, white to gray-white fine with clots of gypsum(?) which fluoresces pale yellow-white.	6-7	0	6	3	6-8	6.5	9.5	8	.003	.003
55	Sandstone, dark-gray silty, with some yellow-brown iron-stained sandstone; trace of gypsum (?).	7-8	1	6	3.5					.003	.003
56	Siltstone, red-brown, 8-8.1 feet; brown-gray siltstone with subordinate sandstone, claystone, and gypsum(?), 8.1-10 feet.	8-10	1	6.5	3.5	8-10	8	12	9.5	.004	.004
57	Siltstone, brown-gray clayey, 10-11 feet; brown-gray to gray silty claystone with sparse gypsum(?), 11-12 feet.	10-12	0.5	7	3.5	10-12	10	13.5	12	.005	.007
58	Claystone, brown-gray to gray silty, 12-12.9 feet; red-brown sandy claystone, 12.9-13 feet; brown-gray to white, clayey, medium-coarse sandstone, 13-14 feet; 0.01 percent fluorescent material.	12-14	2	9	4.5	12-14	11	14	12.5	.005	.005
59	Sandstone, brown-gray to white clayey; traces of fluorescent material.	14-14.5	1	8.5	4	14-16	8	12	10	.003	.003
60	Sandstone, gray-white, silty fine, with small amounts of gray claystone, 14.5-15.5 feet; gray clayey siltstone, 15.5-16 feet.	14.5-16	0	5	3					.003	.002
61	Siltstone, gray to gray-green with some brown silty claystone; traces of fluorescent material.	16-18	0	8	3.5	16-18	10	14	11.5	.004	.002
62	Siltstone, brownish gray-green, with minor amounts of claystone and fine sandstone.	18-20	0	5	3	18-20	8.5	12.5	10	.003	.001
63	Siltstone, gray clayey and brown-white fine sandy siltstone, intermixed; traces of fluorescent material.	20-22	1	7	3.5	20-22	8	12.5	10	.003	.002
64	Siltstone, gray clayey with intermixed brown-white, fine sandy siltstone, 22-22.5 feet; brown-gray siltstone with some claystone and sandstone, 22.5-24 feet; water table at 22.5 feet.	22-24				22-24	8	12	10	.003	.002
65	Siltstone, gray-green to brown-gray and claystone and sandstone.	24-24.5				24-26	9	13	11.5	.003	.002
66	do	24.5-26.5								.003	.001
67	do	26.5-28				26-28	7	11	9.5	.003	.002
68	do	28-29				28-30	7	10	9	.002	.002
69	Siltstone, gray-green sandy	29-30								.003	.001
70	Sandstone, brownish-gray-green silty	30-32				30-32	6.5	9.5	8	.002	.001
71	do	32-33								.003	.001

TABLE 11.—*Lithology, content of uranium and equivalent uranium, and radioactivity of rocks entered by auger holes ES-1–ES-13 (pl. 21), drilled by the U. S. Geological Survey in 1950, Lost Creek schroeckingerite deposit, Red Desert, Wyo.*—Continued

Sample No.	Lithology (sample log)	Field radioactivity								Equivalent uranium in sample (percent)	Uranium in sample (percent)
		Samples				Wall rock					
		Depth (ft)	Scale divisions—0.2 mr per hr			Depth (ft)	Scale divisions—2.0 mr per hr				
			Min	Max	Avg		Min	Max	Avg		
Auger-hole ES-4—Continued											
DS-4- 72	Sandstone, brown-white pebbly, and brown-gray silty sandstone.	33–34				32–34	7	10.5	9	0.003	0.001
73	Caved rock	29–34								.002	.001
74	Sandstone, brown-gray silty pebbly, 34–35.5 feet; light-brown sandy siltstone, 35.5–35.8 feet; brown-gray silty pebbly sandstone, 35.8–37 feet.	34–37				34–36	8	12	10	.004	.001
75	Sandstone, brownish gray-green with subordinate siltstone and pebbles, 37–38 feet; red to red-brown sandy siltstone, 38–39 feet. (Caved at 38 feet.)	37–39								.003	.001
76	Sandstone, brown-gray silty with sparse pebbles, 39–40 feet; red-brown to brown-white silty sandstone, 40–42 feet; brown-gray silty sandstone with some pebbles, 42–44 feet.	39–44								.003	.001
77	Sandstone, brown-gray silty	44–45								.004	.001
78	Sandstone, yellow-brown to brown-gray silty, 45–46 feet; brown-gray sandy siltstone with a little claystone, 46–47 feet; brown-gray silty claystone with faint maroon color, 47–48 feet; brown-gray-green silty sandstone, 48–50 feet.	45–50								.004	.002
	End of hole	50									
Auger-hole ES-5											
DS-5- 79	Sand, brown silty, 0–1 foot; gray-green sandy siltstone, 1–2 feet; 0.5–1 percent fluorescent material (including schroeckingerite).	0–2	2.5	9.5	5	0–2	15	20	18	0.011	0.015

80	Siltstone, gray-green, with a minor amount of claystone and sandstone, 2–3.5 feet; brown sandy claystone, 3.5–4 feet; sample contains 5 percent fluorescent material (including schroeckingerite in pellets).	2–4	7	20	12	2–4	*9.5	*11	*10	.036	.063
81	Sandstone, brown clayey, 4–4.3 feet; gray-brown pebbly sand, 4.3–4.5 feet; gray-green clayey siltstone, 4.5–6 feet; 0.5–1 percent fluorescent material (including schroeckingerite).	4–6	1	7	4	4–6	*7	*9	*8	.007	.010
82	Claystone, gray-green silty, with a little sandstone, 6–6.5 feet; brown to green-gray clayey siltstone with a little sandstone, 6.5–7 feet; 0.1 to 0.5 percent fluorescent material.	6–7	1	8	3.5	6–8	*6.5	*8.8	*8	.006	.00
83	Siltstone, brown-gray sandy clayey, 7–7.2 feet; gray-white silty pebbly sandstone, 7.2–8 feet; brown to green-gray clayey siltstone, 8–9 feet; 0.1 to 0.5 percent fluorescent material.	7–9	0.5	6	3	8–10	*9.5	*11.5	*10.5	.005	.004
84	Siltstone, green-gray sandy, 9–9.8 feet; brown silty claystone, 9.8–10 feet; brown sandy siltstone, 10–10.5 feet; green-gray siltstone with subordinate yellow-brown sandy siltstone, 10.5–11 feet.	9–11	0	6	3	10–12	*8.5	*10.5	*9.5	.004	.002
85	Siltstone, brown-gray sandy, 11–11.3 feet; brownish-gray-green claystone, 11.3–11.7 feet; brown gray-white silty clayey sandstone, 11.7–12.5 feet; gray-white silty sandstone, 12.5–13 feet; traces of fluorescent material.	11–13	1	7	3	12–14	*4.5	*6	*5.5	.004	.001
86	Sandstone, gray silty, with some claystone, 13–14.7 feet; gray-green to brown-gray, sandy clayey siltstone, 14.7–15 feet. Water table at 14.7 feet.	13–15				14–16	*5	*6.5	*5.8	.004	.001
87	Claystone, green-gray sandy silty, 15–16 feet; green-gray clayey siltstone with some sandstone, 16–17 feet.	15–17				16–18	*5	*6.5	*6	.004	.002
88	Siltstone, green-gray sandy clayey, 17–19 feet; green-gray sandy siltstone with some pebbles, 19–20 feet.	17–20				18–20	*5	*6.6	*6	.004	.002
89	Siltstone, green-gray sandy, and sparse pebbles, 20–20.2 feet; brown-gray sandy clayey siltstone, 20.2–21 feet. (Caved at 20 feet.)	20–21								.004	.002
	End of hole	21									

Auger-hole ES–6

DS–6–90	Sand, brown clayey; traces of fluorescent material.	0–1	1	7	3.5	0–2	7.5	11	9	0.004	0.005
91	Sandstone, green-gray, with a little siltstone; 0.01 percent fluorescent material.	1–2	0	6	3.5					.002	.002

TABLE 11.—*Lithology, content of uranium and equivalent uranium, and radioactivity of rocks entered by auger holes ES-1–ES-13 (pl. 21), drilled by the U. S. Geological Survey in 1950, Lost Creek schroeckingerite deposit, Red Desert, Wyo.*—Continued

Sample No.	Lithology (sample log)	Field radioactivity								Equivalent uranium in sample (percent)	Uranium in sample (percent)
		Samples				Wall rock					
		Depth (ft)	Scale divisions—0.2 mr per hr			Depth (ft)	Scale divisions—2.0 mr per hr				
			Min	Max	Avg		Min	Max	Avg		
		Auger-hole ES-6—Continued									
DS-6- 92	Sandstone, brown silty, 2–2.5 feet; gray-white silty sandstone with some pebbles, 2.5–3 feet, 0.05 percent fluorescent material.	2–3	0	6	3	2–4	8	11.5	10	0.003	0.002
93	Sandstone, gray-white to brown silty, 3–3.6 feet; dark gray to brown sandstone with a little siltstone, 3.6–4 feet; 0.01 percent fluorescent material in addition to abundant gypsum.	3–4	0	5.5	3.5	----------	----------	----------	----------	.004	.004
94	Sandstone, green-gray to gray-white silty, 4–5.5 feet; dark-gray to brown-gray silty, sandstone with some claystone, 5.5–6 feet; 1 percent fluorescent material, in addition to some gypsum.	4–6	0	8	4.5	4–6	9.5	14	11.5	.004	.003
95	Sandstone, dark-gray to brown-gray silty, with a little claystone, 6–6.5 feet; light-gray to gray-white silty sandstone, 6.5–7.7 feet; dark-gray silty sandstone, 7.7–8 feet; 0.01 percent fluorescent material.	6–8	1	7	3	6–8	8	12.5	10	.003	.001
96	Siltstone, gray-green sandy, with a little claystone; 0.1–0.5 percent fluorescent material.	8–10	0	6	4	8–10	14.5	18.5	16.5	.004	.002
97	Sandstone, dark-gray to green-gray silty, 10–10.5 feet; brown, sandy, clayey siltstone, 10.5–10.6 feet; green-gray sandy claystone and brown sandy siltstone; 10.6–12 feet; 0.1 percent fluorescent material.	10–12	0	6	4	10–12	----------	----------	----------	.004	.001
98	Claystone, green-gray silty; 0.05 percent fluorescent material.	12–14	1	6.5	4	12–14	15.5	20	17.5	.005	.004
99	Claystone, green-gray silty, 14–14.5 feet; brown to light-brown sandy silty claystone, 14.5–15 feet; 0.5 to 1 percent fluorescent material.	14–15	0	6	4	14–16	*5.5	*7	*6.2	.006	.006

100	Siltstone, gray-green sandy with a minor amount of claystone, 15–15.7 feet; maroon-brown sandy clayey siltstone, 15.7–15.8 feet; gray-green sandy siltstone, 15.8–16 feet; brown clayey siltstone, 16–16.2 feet; gray-green claystone, 16.2–17 feet; (water table at 16.2 feet).	15–17				16–18	*5	*7	*6	.005	.003
101	Sand, gray silty pebbly, 17–18 feet; brown sandy clayey siltstone, 18–19 feet; green-gray silty sandstone, 19–19.5 feet; gray-green sandy clayey siltstone, 19.5–20 feet; brown sandy siltstone, 20–20.5 feet; green-gray silty sandstone, 20.5–21 feet.	17–21				18–20	*4.5	*6	*5.2	.004	.002
						20–22	10	13	11.5		
102	Sandstone, green-gray silty, 21–22 feet; brown to brown-gray sandy silty claystone, 22–23 feet; gray sandy clayey siltstone, 23–23.5 feet; brown-gray silty sandstone, 23.5–24 feet.	21–24				22–24	11.5	16	14	.006	.005
103	Claystone, gray to brown-gray sandy silty, 24–25.5 feet; gray-brown silty sandstone, 25.5–26 feet; gray to brown-gray sandy silty claystone, 26–27 feet; gray sandy clayey siltstone, 27–29 feet.	24–29				24–26	15.5	20	17.5	.004	.002
						26–28	*5	*6	*5.5		
104	Claystone, green-gray silty, with a little sandstone, 29–32 feet; brown-gray sandy clayey siltstone, 32–33 feet. (Caved at 31 feet).	29–33				28–30	14	18	16	.004	.004
						29–31	13	17.5	15.5		
105	Sandstone, green-gray silty fine	33–34								.004	.002
	End of hole	34									
	Auger-hole ES-7										
DS-7-106	Sand, brown silty, 0–1 foot; brown sandy silty clay, 1–2.5 feet; pale-buff sandstone with some siltstone, 2.5–3 feet. Sample contains some gypsum.	0–3	0.5	8	3.5	0–2	7.5	11.5	9	0.005	0.004
107	Sandstone, pale-buff to pale-brown silty, 3–4 feet; brown-red sandy silty claystone, 4–5 feet. Traces of fluorescent material in addition to minor amount of gypsum.	3–5	.5	7	3	2–4	9	12.5	11	.005	.005
108	Sandstone, pale-gray with some siltstone; 0.5–1 percent fluorescent material in addition to very small amount of gypsum.	5–7	1	7	3.5	4–6	11	14.5	13	.003	.001
109	Sandstone, white to pale-gray with a little siltstone; 0.5–1 percent fluorescent material in addition to minor amount of gypsum.	7–9	0	6	2.5	6–8	6	10	8	.003	.001
110	Sandstone, pale-buff to pale-gray silty pebbly, with some gray siltsone intermixed from 10.5–11 feet.	9–11	0	6	3	8–10	6	9.5	8	.003	.001

TABLE 11.—*Lithology, content of uranium and equivalent uranium, and radioactivity of rocks entered by auger holes ES-1–ES-13 (pl. 21), drilled by the U. S. Geological Survey in 1950, Lost Creek schroeckingerite deposit, Red Desert, Wyo.*—Continued

Sample No.	Lithology (sample log)	Field radioactivity								Equivalent uranium in sample (percent)	Uranium in sample (percent)
		Samples				Wall rock					
		Depth (ft)	Scale divisions—0.2 mr per hr			Depth (ft)	Scale divisions—2.0 mr per hr				
			Min	Max	Avg		Min	Max	Avg		
Auger-hole ES-7—Continued											
DS-7-111	Siltstone, dark-gray to brown-gray sandy, 11–12 feet; water table and a thin seam of brown-red clayey siltstone at 12 feet; white sandstone with some siltstone, 12–13 feet. The sample while damp contained 5 percent fluorescent material, but when dry contained no fluorescent material.	11–13	0	7	3.5	10–12	5.5	9	7.5	0.003	0.001
112	Caved rock (mostly white sandstone)	11–13				12–14	6.5	10	8.5	.002	.001
113	Sandstone, pale-buff pebbly	13–16				14–16	5.5	9	7.5	.002	.001
114	Sandstone, pale-buff pebbly, with traces of brown-red siltstone.	16–19				16–18	6	9.5	7.5	.002	.001
115	Caved rock (mostly pebbly sandstone)	13–19				18–20	6	10	8.5	.004	.001
116	Sandstone, pale-gray silty, with a minor amount of brown siltstone, 19–22 feet; red-brown silty claystone with a little sandstone, 22–23 feet; gray-green clayey siltstone intermixed with gray silty claystone and some sandstone, 23–24 feet.	19–24				20–22 22–24	9 9	12.5 12.5	11 11	.006	.001
117	Claystone, gray-green silty, and subordinate sandstone, 24–24.5 feet; brown-green to gray-green sandy clayey siltstone, 24.5–25.5 feet; gray-green silty sandstone, 25.5–27 feet; gray-green very sandy siltstone, 27–28 feet.	24–28				24–26 26–28	9 7.5	12.5 11.5	10.5 9.5	.002	.001
118	Claystone, gray-green sandy silty, 28–29 feet; brown to gray-green sandy clayey siltstone, 29–30 feet.	28–30				28–30	11	15.5	13.5	.004	.001
119	Sandstone, brown-gray to green-gray silty, 30–33 feet; gray-green silty claystone, 33–33.5 feet; gray-brown sandy siltstone with some claystone, 33.5–35 feet.	30–35				30–32 32–34 33–35	8 6.5 7	11.5 11 11.5	10 8.5 9	.003	.001
120	Claystone, gray-green sandy silty, 35–36 feet; gray-brown silty sandstone, 36–36.5 feet. (Caved at 35 feet.)	35–36.5								.005	.002

121	Claystone, green-gray sandy silty, 36.5–37 feet; gray-green sandy clayey siltstone, 37–38 feet.	36.5–38								.005	.002
122	Claystone, gray-green sandy silty, 38–39.5 feet; gray-green sandy siltstone with a little claystone, 39.5–40 feet.	38–40								.004	.002
123	Claystone, gray-green silty, intermixed with gray-green sandy clayey siltstone.	40–41								.006	.002
124	Claystone, bluish-gray-green silty and a little sandstone.	41–44								.004	.004
125	Claystone, bluish gray-green silty intermixed with gray-green sandy clayey siltstone.	44–45								.004	.002
126	Siltstone, bluish-gray-green very sandy clayey.	45–46								.001	.001
127	Siltstone, bluish-gray-green very sandy clayey 46–47.5 feet; gray-brown to gray-green sandy claystone and clayey siltstone, intermixed, 47.5–48.5 feet; bluish-gray-green very sandy clay-siltstone, 48.5–50 feet.	46–50								.003	.002
	End of hole	50									

Auger-hole ES–8

DS–8–128	Sand, brown to brown-buff silty pebbly, with sparse gypsum(?).	0–2	0	5.5	3	0–2	8	12	10	0.004	0.000
129	Sandstone, buff, with a smaller amount of siltstone pebbles, and gypsum(?).	2–4	0	7	3	2–4	8	12	10.5	.004	.000
130	Siltstone, red-buff sandy, 4–4.5 feet; gray-brown sandy siltstone, 4.5–6 feet; 0.1 percent fluorescent material and sparse gypsum(?).	4–6	0.5	8	4	4–6	10	13.5	11.5	.005	.002
131	Siltstone, buff-gray sandy, 0.5 percent fluorescent material and some gypsum(?).	6–8	1	6.5	4	6–8	11.5	15.5	13	.005	.001
132	Siltstone, buff-gray sandy, 8–8.5 feet; buff silty sandstone, 8.5–9.5 feet; gray sandy siltstone, 9.5–10.5 feet; 0.1–0.5 percent fluorescent material and some gypsum(?).	8–10	1	8	4	8–10	9.5	13.5	11.5	.004	.000
133	Siltstone, buff-gray sandy, 10–11.5 feet; green-gray sandy siltstone, 11.5–12 feet; 0.1–0.5 percent fluorescent material and sparse gypsum(?).	10–12	1.5	7.5	4	10–12	8	11.5	10	.002	.000
134	Siltstone, buff-gray sandy, 12–13 feet; buff-gray silty sandstone, 13–14 feet; less than 0.1 percent fluorescent material.	12–14	1	6	3.5	12–14	8.5	12	10.5	.003	.000
135	Sandstone, gray silty, 14–14.2 feet; pale yellow-buff sandy siltstone, 14.2–15 feet; 0.5 percent fluorescent material in addition to some gypsum(?).	14–15	1	7	4	14–16	10	14	12.5	.003	.000
136	Siltstone, buff-gray sandy, 15–16.5 feet; water table at 16.5 feet; pale-buff silty sandstone, 16.5–16.9 feet; gray sandy clayey siltstone, 16.9–17 feet; 0.5 percent fluorescent material.	15–17	1	7.5	4	16–18	8	12.5	10.5	.003	.000

TABLE 11.—*Lithology, content of uranium and equivalent uranium, and radioactivity of rocks entered by auger holes ES-1–ES-13 (pl. 21), drilled by the U. S. Geological Survey in 1950, Lost Creek schroeckingerite deposit, Red Desert, Wyo.*—Continued

Sample No.	Lithology (sample log)	Field radioactivity								Equivalent uranium in sample (percent)	Uranium in sample (percent)
		Samples				Wall rock					
		Depth (ft)	Scale divisions—0.2 mr per hr			Depth (ft)	Scale divisions—2.0 mr per hr				
			Min	Max	Avg		Min	Max	Avg		
Auger-hole ES-8—Continued											
DS-8-137	Claystone, brown-red sandy silty, 17–17.2 feet; buff sandy clayey siltstone, 17.2–18.5 feet; brown-buff sandy clayey siltstone with a little gray claystone, 18.5–20.5 feet; gray-buff sandy silty claystone, 20.5–21 feet; gray-white to brown-buff sandy siltstone with some claystone, 21–22 feet.	17–22	----------	----------	----------	18–20	10	14	12	0.005	0.000
	End of hole	22									
Auger-hole ES-9											
DS-9-138	Sand, brown to brown-white silty pebbly with some gypsum(?).	0–2	0	6	3	0–2	8	11.5	9.5	0.004	0.000
139	Sandstone, buff-white silty with sparse pebbles and gypsum(?).	2–4	0	6	3	2–4	8.5	12	10	.003	.000
140	Sandstone, buff-white silty pebbly with sparse gypsum(?).	4–6	0	6	3.5	4–6	8.5	11.5	10	.003	.000
141	ditto	6–8	0	6	3	6–8	8	11.5	10	.003	.000
142	Sandstone, buff-white silty pebbly; traces of fluorescent material and gypsum(?).	8–10	1	4.5	2.5	8–10	8	11.5	10	.004	.000
143	Sandstone, pale-buff silty pebbly; 0.01 percent fluorescent material and gypsum(?).	10–12	1	5.5	3	10–12	8.5	11	10	.003	.000
144	Sandstone, pale-buff silty pebbly traces of fluorescent material and gypsum(?).	12–14	0.5	4.5	2.5	12–14	8	11.5	9.5	.003	.000
145	Sandstone, pale-buff silty pebbly; 0.05 percent fluorescent material and gypsum(?).	14–16	0.5	5.5	3	14–16	8.5	12	10.5	.002	.000
146	Sandstone, pale-buff silty pebbly; 0.1 percent fluorescent material and sparse gypsum(?).	16–18	0	5.5	3	16–18	10	13.5	12	.003	.000
147	Sandstone, pale-buff silty pebbly; 0.1–0.5 percent fluorescent material.	18–20	1	6	3.5	18–20	10.5	14.5	12.5	.004	.000

148	Sandstone, brownish pale-buff to brown-gray pebbly and a little siltstone; 0.5–1 percent fluorescent material.	20–22	0	7.5	4	20–22	11	15.5	13.5	.003	.000
149	In part caved rock from 20–22 feet. Brownish pale-buff to brown-gray pebble sandstone with subordinate buff-gray-white sandy siltstone; sample contains 0.1–0.5 percent fluorescent material.	20–23	0.5	6	3.5	22–24	11.5	15	13	.003	.000
150	Siltstone, buff gray-white sandy, with traces of fluorescent material.	22–24	0	6.5	3.5	24–26	10.5	14.5	13	.004	.001
151	Sandstone, pale-buff to pale-brown, very silty; sample contains 0.1 percent fluorescent material.	24–26	0	6	3.5	25–27	9	13.5	11	.003	.000
152	Siltstone, light-gray sandy, and intermixed pale-buff silty sandstone from 26–27 feet; water table reached at 27 feet; pale-buff silty sandstone with minor amounts of light-gray sandy siltstone, 27–29 feet; sample contains traces of fluorescent material. (Caved at 27 feet.)	26–29	0	8	4	----------	----------	----------	----------	.004	.000
	End of hole	29									

Auger-hole ES–10

DS–10–153	Sandstone, brown silty with a few pebbles; sample contains 0.1–0.5 percent fluorescent material.	0–2	0	6.5	3.5	0–2	9	13.5	10.5	0.005	0.002
154	Sandstone, buff-brown silty, 2–2.7 feet; brown sandy siltstone with some claystone, 2.7–3 feet; brown-red to grayish-red-brown silty claystone with some sandstone, 3–4 feet; 0.5 percent fluorescent material and minor gypsum(?).	2–4	0	8	4	2–4	13.5	18.5	15.5	.007	.005
155	Siltstone, red-brown to brownish-gray-buff with intermixed claystone and sandstone; sample contains about 0.5 percent fluorescent material.	4–6	1	9	4.5	4–6	14.5	19.5	17	.007	.004
156	Siltstone, brown-gray to buff-gray with some claystone and sandstone from 6–7.5 feet; green-gray siltstone with some sandstone, 7.5–8 feet; 2–5 percent fluorescent material.	6–8	0	14	6	6–8	13	17.5	15	.007	.006
157	Siltstone, green-gray sandy, 8–10.5 feet; brownish-green-gray sandy siltstone, 10.5–11 feet; 1–2 percent fluorescent material.	8–11	0	7	4.5	8–10	13	17.5	15	.004	.001
158	Siltstone, brown-gray to green-gray sandy, 11–12 feet; gray-green siltstone with a small amount of sandstone, 12–13 feet; 0.5–1 percent fluorescent material.	11–13	----------	----------	----------	10–12	12.5	16.5	14.5	.004	.001

TABLE 11.—*Lithology, content of uranium and equivalent uranium, and radioactivity of rocks entered by auger holes ES-1–ES-13 (pl. 21), drilled by the U. S. Geological Survey in 1950, Lost Creek schroeckingerite deposit, Red Desert, Wyo.*—Continued

Sample No.	Lithology (sample log)	Field radioactivity								Equivalent uranium in sample (percent)	Uranium in sample (percent)
		Samples				Wall rock					
		Depth (ft)	Scale divisions—0.2 mr per hr			Depth (ft)	Scale divisions—2.0 mr per hr				
			Min	Max	Avg		Min	Max	Avg		
Auger-hole ES-10—Continued											
DS-10-159	Siltstone, brownish-green-gray sandy 13–14 feet; green-gray sandy siltstone, 14–14.4 feet; red-brown siltstone with some sandstone, 14.4–14.7 feet; intermixed red-brown to green-gray clayey siltstone and sandy claystone, water-bearing, 14.7–15 feet; 0.5 percent fluorescent material.	13–15				12–14	12	16	14	0.004	0.001
160	Claystone green-gray and brown-gray silty, and a little sandstone, water-bearing 15–16 feet; brown-gray to red-brown sandy siltstone, dry, 16–19 feet.	15–19				16–18	11.5	16	14	.004	.001
161	(Water table at 19 feet.) Siltstone, yellow-brown sandy, 19–19.2 feet; brown-gray sandy siltstone, 19.2–20.5 feet; brown-gray to gray-white silty sandstone, 20.5–24 feet. (Caved at 20 feet.)	19–24				18–20	12	16.5	14	.003	.000
	End of hole	24									
Auger-hole ES-11											
DS-11-162	Sandstone, brown slightly silty, 0–1 foot; buff-brown very silty sandstone, 1–2 feet; traces of fluorescent material.	0–2				0–2	6.5	10	8	0.002	0.000
163	Sandstone, buff, very silty, with traces of fluorescent material.	2–4				2–4	7	10	8.5	.002	.000
164	Sandstone, buff, very silty, 4–5 feet; brown sandy siltstone, 5–6 feet; 0.1 percent fluorescent material.	4–6				4–6	6.5	10	8.5	.003	.000
165	Siltstone, brown sandy clayey, with traces of fluorescent material.	6–8				6–8	7	11	8.5	.002	.000

166	Claystone (or shale), brown silty platy, with some sandstone and traces of fluorescent material.	8–10				8–10	7.5	11.5	9	.002	.001
167	Claystone, brown silty (hard, platy), with a little sandstone; 0.01 percent fluorescent material.	10–12				10–12	7.5	11.5	9	.002	.001
168	Claystone, brown slightly silty (hard, platy), contaminated with overlying material; contains 0.01 percent fluorescent material.	12–14				12–14	7	11	9	.003	.000
169	Claystone, brown slightly silty, (hard, platy), 14–17.5 feet; brown to yellow-brown sandy clayey siltstone, 17.5–17.7 feet; brown-gray to gray sandy siltstone, 17.7–19 feet; sample is contaminated and contains 0.5 percent fluorescent material.	14–19				14–16 16–18	7 9	12 13	10 11	.003	.000
170	Siltstone, gray, and buff slightly green-gray clayey siltstone, intermixed; traces of fluorescent material. (Caved at 20 feet.)	19–21								.003	.000
171	Siltstone, gray and brown-gray claystone; sample is contaminated with overlying material and contains 0.01–0.05 percent fluorescent material.	21–23								.003	.000
	End of hole	23									

Auger-hole ES–12

DS–12–172	Sandstone, buff-brown very silty	0–2				0–2	8.5	11.5	10	0.003	0.000
173	Sandstone, buff-brown very silty, 2–3 feet; grayish green-white slightly sandy siltstone, 3–4 feet; sample contains some gypsum.	2–4				2–4	9.5	14	12	.004	.003
174	Siltstone, grayish-green-brown sandy clayey, 4–5 feet; gray-brown silty claystone (hard, platy), 5–6 feet; sample contains sparse gypsum.	4–6				4–6	10	14	12.5	.005	.004
175	Claystone, maroon-brown silty, (hard, platy), 6–7.5 feet; light-green claystone, 7.5–8 feet; sample contains traces of fluorescent material in addition to minor amounts of gypsum.	6–8				6–8	8.5	13	10.5	.005	.003
176	Claystone, gray-green silty, with traces of fluorescent material.	8–10				8–10	12	16	13.5	.004	.001
177	Siltstone, gray-green clayey, 10–11.7 feet; brown to gray-brown clayey siltstone, 11.7–12 feet. Sample contains traces of fluorescent material.	10–12				10–12	12.5	16.5	14.5	.004	.001
178	Caved rock (gray-green clayey siltstone and brown clayey siltstone).	10–12								.005	.001
179	Siltstone, gray-green, with minor quantities of brown silty claystone; sample contains traces of fluorescent material.	12–14				12–14	12.5	19	15	.004	.001

TABLE 11.—*Lithology, content of uranium and equivalent uranium, and radioactivity of rocks entered by auger holes ES–1–ES–13 (pl. 21), drilled by the U. S. Geological Survey in 1950, Lost Creek schroeckingerite deposit, Red Desert, Wyo.*—Continued

Sample No.	Lithology (sample log)	Field radioactivity								Equivalent uranium in sample (percent)	Uranium in sample (percent)
		Samples				Wall rock					
		Depth (ft)	Scale divisions—0.2 mr per hr			Depth (ft)	Scale divisions—2.0 mr per hr				
			Min	Max	Avg		Min	Max	Avg		
Auger-hole ES–12—Continued											
DS–12–180	Siltstone, gray-green to buff-green clayey, with traces of fluorescent material.	14–16				14–16	14	19	16	0.005	0.002
181	Siltstone, gray-green to green-gray, very clayey, contaminated with overlying rock; sample contains less than 0.1 percent fluorescent material.	16–18				16–18	14	19	16	.004	.001
182	Siltstone, gray-green to green-gray, very clayey, contaminated with overlying rock; sample contains traces of fluorescent material.	18–20				18–20	12.5	16.5	14.5	.005	.001
183	Claystone, gray-green silty water-bearing, 20–21.5 feet; gray-green clayey siltstone, dry, 21.5–23 feet; sample is contaminated with material from above and contains traces of fluorescent material.	20–23				20–22	10.5	16	13	.004	.001
184	(Water table at 23 feet.) Gray-green silty claystone, 23–23.5 feet; brownish-gray-green very silty claystone, 23.5–24.5 feet; light brown silty claystone, 24.5–25 feet. (Caved at 23.5 feet.)	23–25				21.5–23.5	10.5	15	13	.004	.000
	End of hole	25									
Auger-hole ES–13											
DS–13–185	Sand, brown or buff silty, with a few pebbles	0–2				0–2	9	12	10.5	0.003	0.000
186	Sandstone, buff pebbly, with subordinate siltstone.	2–4				2–4	8.5	13.5	10.5	.003	.000
187	Sandstone, buff to pale-buff silty pebbly	4–6				4–6	8.5	12.5	11	.003	.000
188	Sandstone, buff to pale-buff silty pebbly (pebbles as much as half an inch in diameter).	6–8				6–8	15	20	17.5	.003	.000

189	do	8–10				8–10	10	13	11.5	.004	.000
190	Sandstone, pale-buff silty pebbly (pebbles as much as three-fourths of an inch in diameter).	10–12				10–12	9	13	11	.003	.000
191	Sandstone, pale-buff silty pebbly (some pebbles are as much as 1 inch in diameter; some ¼-inch grains are feldspar).	12–14				12–14	10	14	12	.004	.000
192	Sandstone, yellowish pale-buff silty pebbly, 14–15.7 feet; gray-green and maroon-brown silty claystone, 15.7–16 feet (trace of fluorescent material).	14–16				14–16	15	19	16.5	.004	.000
193	Sandstone, brown-buff, silty pebbly (some gray-green claystone).	16–18				16–18	9	14	11.5	.005	.001
194	Sandstone, pebbly, brown to gray, silty, with some brown siltstone, 18–19.5 feet; gray-brown sandy siltstone, 19.5–21.5 feet; pale-buff sandy siltstone, 21.5–22 feet (trace fluorescent material).	18–22				18–20	9.5	14	11.5	.003	.000
						20–22	2.5	15	11		
195	Sandstone, pale-gray, silty, 22–23 feet; pale-buff sandy siltstone, 23–24 feet; sample contaminated with caved rock.	22–24				22–24	9	14	11	.003	.000
196	Sandstone, gray-buff to pale-buff silty, with some pebbles; sample contaminated.	24–29				24–26	8.5	14	12	.004	.000
						26–28	9	13.5	11.5		
197	Sandstone, gray-buff silty 29–32 feet; maroon and gray-green waxy claystone with minor sandstone, 32–33 feet; buff-brown clayey siltstone, 33–34 feet (trace of fluorescent material). Sample contaminated.	29–34				28–30	7.5	13	11	.003	.000
						30–32	11	15	12.5		
						32–34	11	15.5	13.5		
198	Siltstone, gray-buff; sample contaminated. (Caved at 34 feet.) Hole abandoned at 35 feet without reaching water table.	34–35								.004	.000

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