Geology of the Lost Creek Schroeckingerite Deposits Sweetwater County, Wyoming

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By DOUGLAS M. SHERIDAN, CHARLES H. MAXWELL, *and* JOHN T. COLLIER

CONTRIBUTIONS TO THE GEOLOGY OF URANIUM

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GEOLOGY OF THE LOST CREEK SCHROECKINGERITE DEPOSITS, SWEETWATER COUNTY, WYOMING

By Douglas M. Sheridan, Charles H. Maxwell, and John T. Collier

ABSTRACT

The largest known group of schroeckingerite deposits in the world is located in the Lost Creek area in northern Sweetwater County, Wyo. Schroeckingerite, a hydrated fluo-carbonate-sulfate of sodium, calcium, and uranium, occurs near the surface in caliche-type deposits in an area of about one-half square mile.

The Lost Creek schroeckingerite area is on the northeastern edge of the Red Desert and is in the north-central part of the Great Divide Basin, a topographic basin of interior drainage. The entire region is land of low relief with altitudes between 6,000 and 7,000 feet above sea level. The bedrock of the basin consists of Tertiary formations, but much of it is concealed by Quaternary deposits. Older rocks of Mesozoic and Paleozoic age are exposed only near the margins of the basin.

The Tertiary rocks in the Lost Creek area consist of about 5,200 feet of sandstone, siltstone, claystone, and shale; coal beds and volcanic effusive material are also found in parts of the sequence. The oldest unit, the Fort Union formation of Paleocene age, is overlain unconformably by an intertonguing sequence of Eocene sedimentary rocks—the Wasatch, Green River, and Battle Spring formations. Overlying the intertongued sequence is the Bridger formation of Eocene age. At the top of the Tertiary sequence are conglomerates of Oligocene(?) age, and conglomerate and tuffaceous sandstone of Miocene age.

A northwestward-trending syncline in the Lost Creek area is cut by northwestward- and northeastward-trending sets of faults. The northwestward-trending faults are related to a major fault system that extends for a total distance of about 75 miles. The longest fault in the Lost Creek area, a curving fault along the northern limb of the syncline, has an apparent stratigraphic displacement between 2,500 and 4,000 feet. The southern limb of the syncline is cut by the Cyclone Rim zone of faulting that trends N. 72° W. for at least 14 miles. This zone consists of a complex pattern of faults, but the net stratigraphic displacement at most places along the zone is probably less than 400 feet. Much of the faulting in the Lost Creek area may be Miocene or post-Miocene in age.

The area containing schroeckingerite deposits lies east of Lost Creek along the southern limb of the syncline and is partly within and partly north of the Cyclone Rim zone of faulting. The deposits are distributed irregularly within this area, but the depth of occurrence is limited to the level of the ground water. Most of the deposits occur in northward-dipping strata of Eocene age in a zone 2 to 8 feet below the surface of the ground.

Some of the deposits lie partly or wholly within the surficial material of Quaternary age.

Most commonly the schroeckingerite deposits are elongate lenticular bodies that lie subparallel to the surface of the ground, generally across fault planes, bedding planes, and the unconformity at the base of the Quaternary overburden. Other deposits are tabular, branching, or irregular in shape. The average thickness of the deposits is about 1.5 feet. The richest concentrations of schroeckingerite occur in fine-grained host rocks, especially siltstone and silty or sandy claystone, but the deposits have been found in many types of sedimentary rocks, ranging from shale to coarse pebbly sandstone.

Schroeckingerite is a greenish-yellow to yellow platy mineral having the chemical formula, $NaCa_3(UO_2)(CO_3)_3(SO_4)F \cdot 10H_2O$. Pure schroeckingerite contains about 27 percent uranium. The outstanding physical characteristic of the mineral is its brilliant yellow-green fluorescence in ultraviolet light. It occurs most commonly in the form of concretions or pellets, generally 0.2 inch in diameter, but some are as much as 1.5 inches in diameter. Gypsum is usually interleaved with the schroeckingerite flakes in the pellets. Schroeckingerite also occurs as small flaky crystals coating sand grains; as small tabular masses along bedding planes in shale and along shrinkage cracks; as fine grains associated with silica, carbonate, or gypsum in encrustations and small veinlets; and as minute grains in the white efflorescent salts of surface encrustations. No other uranium mineral has been identified in the Lost Creek schroeckingerite deposits and the only other associated minerals, other than the minerals of the host rock, are gypsum, opal, and carbonates.

The schroeckingerite in the Lost Creek area is believed to form by a simple process of crystallization from uraniferous waters, a process similar to that by which caliche deposits of similar salts are formed in other arid and semiarid regions. The immediate source of uranium in the schroeckingerite is the ground water, which contains as much as 46 parts per million in uranium.

The most probable source of the uranium in the schroeckingerite and the uraniferous ground water is concealed uranium deposits in the Lost Creek area, which are believed to be relatively high in grade compared to the schroeckingerite deposits. The hypothetical deposits may be located at depth in the general area of schroeckingerite deposition or they may be located laterally from the area of deposition along one or more of the many faults in the area.

Derivation of the uranium by leaching of widespread uraniferous source rocks of low grade is considered a less probable genetic hypothesis because it does not explain the concentration of so much schroeckingerite in this single relatively restricted part of the Great Divide Basin.

The Lost Creek schroeckingerite deposits constitute a large reserve of low-grade uraniferous material. The uranium content of samples obtained from deposits cut by U.S. Geological Survey trenches ranges from 0.001 percent to 0.260 percent. Most of the samples contain less than 0.050 percent uranium. The low grade of large samples of the naturally occurring material has been detrimental to the commercial development of the deposits. Schroeckingerite, however, is readily dissolved in the local natural waters. The high solubility is a factor in favor of the potential economic development of the deposits.

INTRODUCTION

Deposits of schroeckingerite, a hydrated fluo-carbonate-sulfate of sodium, calcium, and uranium, occur over a large area in the vicinity of

Lost Creek in northern Sweetwater County, Wyo. This area contains the largest known concentration of schroeckingerite in the world. Elsewhere, schroeckingerite generally occurs in relatively small quantities as a secondary mineral associated with other uranium minerals. No other uranium mineral has been identified as yet in the immediate vicinity of the Lost Creek deposits.

No commercial production has been recorded from the Lost Creek area, but a large reserve of low-grade uraniferous material is contained in the near-surface schroeckingerite deposits.

This report presents the geologic results of an exploration program in the Lost Creek area by the U.S. Geological Survey in 1951–52 on behalf of the Division of Raw Materials of the U.S. Atomic Energy Commission.

LOCATION AND ACCESSIBILITY

The Lost Creek area, in Sweetwater and Fremont Counties, Wyo., is on the northeastern edge of the Red Desert and in the north-central part of the Great Divide Basin (pl. 35). All the known schroeckingerite deposits are in an elongate area covering approximately half a square mile on the east side of Lost Creek in northern Sweetwater County, in parts of secs. 29–33, T. 26 N., R. 94 W., and in part of sec. 25, T. 26 N., R. 95 W., sixth principal meridian.

The Lost Creek schroeckingerite deposits may be reached by travelling north 41 miles from Wamsutter, Wyo., which is 40 miles west of Rawlins on U.S. Highway 30 and the main line of the Union Pacific railroad (pl. 35). The road from Wamsutter to the deposits is graded in part and in part unimproved. Other unimproved roads connect the schroeckingerite locality with Bairoil, Lamont, and U.S. Highway 287 to the east; Crooks Gap and U.S. Highway 287 to the north; State Route 28 to the west, and U.S. Highway 30 and Rock Springs to the southwest.

GEOGRAPHY

The Great Divide Basin is the major physiographic feature of southwestern Wyoming, and the area described in this report is within it. The Continental Divide splits at the southeast end of the Wind River Range: the north branch trends eastward toward the Seminoe Mountains, then unevenly southward near Rawlins; the south branch extends southward toward Superior, then eastward along the Cathedral Bluffs south of Wamsutter. The branches converge again at the north end of the Sierra Madre Mountains (pl. 35). The basin of interior drainage enclosed by the divergence of the Continental Divide is 3,600 square miles in area; it is not a single topographic depres-

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sion but includes a number of drainage basins with alkali lakes and playas.

Most of the Great Divide Basin (Fenneman, 1931, p. 143–144) is included in the larger area of the Red Desert of Wyoming. The Red Desert, which was named from the prevalent red color of the soil (Hague and Emmons, 1877, p. 211; Hayden, 1871, p. 72; King, 1878, p. 364), extends from Picket Lake (pl. 35) southward into Colorado.

The region comprising the Great Divide Basin and the Red Desert is a land of low relief, with altitudes ranging between 6,000 and 7,000 feet above sea level. It is broken only by small rounded hills and low buttes. In describing this region south of the Sweetwater River, Hayden (1871, p. 34) wrote:

> From the summits the eye extends far southward, fifty miles or more, over a most desolate, barren plain, with here and there a table-top butte to show that the surface was once much higher than at present. It is cut up into innumerable valleys, which give to the surface an irregular, wavy appearance. Not a tree or shrub greets the vision over this vast desert waste.

The summits to which Hayden referred are the lower range of hills on the south side of the Sweetwater River along the northern branch of the Continental Divide, probably the Cyclone Rim in the vicinity of Picket Lake.

The principal topographic feature of the Lost Creek area (pl. 35) is the dissected hogback of Cyclone Rim, which lies to the north and west of the schroeckingerite locality. Lost Creek has its source near Crooks Mountain and drains southward into Lost Lake. The creek is seasonally intermittent over most of its course, and the lake is dry except in flood season.

The climate of the region is arid and semiarid. The vegetation is sparse and consists of low-growing shrubs of greasewood, saltbrush, sagebrush, and some desert and prairie grasses and herbs. Much of the area is underlain by sedimentary rocks relatively high in sulfate minerals. The presence of numerous deposits of caliche and many alkali flats and alkali lakes undoubtedly accounts for the sparseness of the vegetation and for the selective growth of the sagebrush. Sagebrush is an indicator of deep soils largely free from alkali.

The region is primarily used for sheep-grazing. A few cattle range in the places where forage is heavy enough to support them. Pronghorn antelope are abundant and wild horses are not uncommon. A small herd of bison is seen occasionally. Sage hens and prairie chickens are abundant where there is natural water, and ducks and geese are common on the larger bodies of water during migration. The natural supply of water is augmented by many wells throughout this desert country.

PREVIOUS WORK

Deposits of an unidentified yellow mineral in the Lost Creek area were first noted by Mrs. Minnie McCormick, now deceased, of Wamsutter, Wyo. At first, mineralogists thought the mineral was a new species, "dakeite", but later it was proved to be schroeckingerite (p. 423).

Many geologic examinations of the Lost Creek schroeckingerite deposits have been made since their discovery by Mrs. McCormick. Early reports include those by Knight and Gilbert [1] and by Dake (1938, p. 7–8, 23–25). J. O. Harder and D. G. Wyant (written communication, 1944), A. L. Slaughter and J. M. Nelson (written communication, 1946), and D. G. Wyant (written communication, 1948) made field examinations of the Lost Creek deposits as part of a reconnaissance search for uranium by the U.S. Geological Survey. G. B. Guillotte (written communication, 1945) examined the deposits for the Manhattan Engineer District, and C. C. Towle, Jr., (written communication, 1948) made a field examination for the U.S. Atomic Energy Commission.

In 1948 the deposits were explored by Uranium Inc. of Denver, Colo., in about 3,900 feet of trenches, 13 pits, a few cuts by a bulldozer, and many shallow auger holes. Other exploration by Uranium Inc. and by various claim-owners has been done from time to time.

Preliminary field mapping and drilling of 39 shallow auger holes and 13 jeep auger holes in the Lost Creek area was done during 10½ weeks in 1949 and 1950 by the U.S. Geological Survey as part of a reconnaissance study of uranium in the Red Desert. This work was done under the supervision of D. G. Wyant, who was assisted at various times by W. N. Sharp, D. M. Sheridan, H. L. Bauer, and A. J. Erickson. The results of the preliminary studies have been described by Wyant, Sharp, and Sheridan (1956).

PRESENT INVESTIGATION

The purpose of the present investigation was to study the geology of the Lost Creek area and to evaluate the schroeckingerite deposits as a potential source of uranium. The preliminary work in 1949 and 1950 (Wyant, Sharp, and Sheridan, 1956, p. 275) showed that additional exploration was necessary in order to make an adequate study of the economic geology of the deposits.

In 1951 and 1952 a total of 51 weeks of field studies and exploration was done under the supervision of Sheridan. Collier began fieldwork in August 1951, and Maxwell began fieldwork in September 1952. The three authors were assisted at various times by L. R. Page, A. J.

[1] Knight, S. H., and Gilbert, C. J., The geological occurrence, chemical composition and optical properties of a new uranium mineral: Talk presented before the chemistry section of the American Association for the Advancement of Science at Denver, Colo., June 1937.

Erickson, R. S. Sears, W. S. Cavender, E. P. Beroni, C. T. Pierson, A. M. Heyman, and A. W. Rose. Engineering work during the exploration was done by E. S. Hanley, J. S. Adair, and H. B. Nickelson, who were assisted at various times by J. C. Thomas, D. E. Blake, and H. L. Bittle.

Exploratory work by the U.S. Geological Survey during the present investigation included both contractual work done under the direction of the Survey and work done directly by the Survey. Excavation of 13 trenches, totalling 16,460 feet in length, and drilling of 70 bucket holes, totalling 1,212 feet, was done by private contractors. In addition, 116 auger holes, totalling 2,349 feet, were drilled by Geological Survey personnel using a government-owned jeep-mounted auger drill. The trenches averaged 8 feet in depth and 4 feet in width and had vertical walls. The maximum depth of all bucket holes and auger holes, including the 13 auger holes drilled for the previous study (Wyant, Sharp, and Sheridan, 1956, p. 265–267), was 51 feet.

Geologic fieldwork included detailed mapping of both walls of each trench by tape and level (scale 1:120); mapping of 7½ square miles by plane-table (scales, 1:2,400 and 1:9,600); logging of the rock types and gamma-ray radioactivity of drill holes; checking stratigraphic data in the area; making a plane-table traverse, 1 mile in length, for additional control in mapping. Samples of water were obtained from representative parts of the Lost Creek area and nearby localities, and traverses were made with a scintillometer for radioactivity data over representative parts of the mapped area. A total of 2,024 samples were obtained from schroeckingerite deposits and host rock in the trenches in order to make a detailed study of grade. The results of the exploration were described in a preliminary report by Sheridan, Collier, and Maxwell (1953, p. 110–111).

ACKNOWLEDGMENTS

The authors are indebted to C. C. Towle, Jr., and J. F. Foran, of the Atomic Energy Commission, for their helpful advice. Many members of the U.S. Geological Survey contributed valuable comments and advice during the field and office work. Field data contributed by G. N. Pipiringos and Harold Masursky proved valuable in mapping the areal geology of the Lost Creek area. Analytical work was supervised by L. F. Rader, Jr. of the U.S. Geological Survey. Analyses of rock samples for equivalent uranium were made by S. P. Furman, J. P. Schuch, and J. N. Rosholt, Jr. Chemical analyses of rock samples for uranium were made by Wayne Mountjoy, W. W. Niles, G. W. Boyes, Jr., G. T. Burrow, Rene F. Dufour, J. P. Schuch, H. P. I. Peterson, R. C. Tripp, J. S. Wahlberg, J. W. T. Meadows, and E. C. Mallory, Jr. Chemical analyses of water samples were made by

Wayne Mountjoy, J. W. T. Meadows, W. W. Niles, J. N. Rosholt, Jr., J. P. Schuch, G. T. Burrow, G. W. Boyes, Jr., Rene F. Dufour, J. S. Wahlberg, and Claude Huffman, Jr. Mineralogic indentifications were made by Alan G. King and the authors. Wayne Mountjoy and Harold Masursky contributed data from leaching experiments. Fossil identifications were made by Richard Rezak, J. B. Reeside, Jr., and I. G. Sohn, all of the U.S. Geological Survey, and by D. H. Dunkle of the U.S. National Museum.

Stockmen and residents of neighboring communities were courteous and cooperative. Mrs. Minnie McCormick, before her untimely death, provided much valuable information, and her friendly generosity and inspiration are gratefully remembered. Particular thanks are due to John McCormick and his family for their kindness and cordial western hospitality. The writers also wish to thank Kleber Hadsell, Frank Hadsell, and Gasper Meyer for the use of their cabin at Lost Creek and for their cooperation on many occasions. Tom Whelan, Mr. and Mrs. John Bugas, Mr. and Mrs. Ed Grynch, Vic Westberg, Ed Westberg, and a great many others extended their hospitality on many occasions.

The authors wish to express their appreciation for the cooperation of all Survey colleagues and contractual personnel during the extremely windy and cold conditions under which much of the fieldwork was done.

GENERAL GEOLOGY

REGIONAL GEOLOGIC SETTING

Sedimentary rocks of Tertiary age make up most of the bedrock of the Great Divide Basin. Rocks of Eocene age are predominant, with less abundant rocks of Paleocene, Oligocene, and Miocene age. To the east, the Tertiary terrane is delimited by exposures of Cretaceous sedimentary rocks along the Ferris Mountains and Muddy Gap area, along the Rawlins uplift, north of Rawlins, and along the Sierra Madre. Tertiary sedimentary rocks extend southward from the Great Divide Basin through the Washakie Basin to the Uinta Mountains in Colorado and Utah, where rocks of Precambrian, Paleozoic, Mesozoic, and Cenozoic age are exposed. To the west, the area of Tertiary sedimentary rocks extends nearly to the western border of Wyoming but is broken by the Rock Springs anticline and the Leucite Hills, where Cretaceous sedimentary rocks and Tertiary intrusive and extrusive rocks are exposed. To the northwest, Precambrian granitic rocks in the core of the Wind River Range border the Great Divide Basin. The anticlinal nose of the Wind River Range, with its exposed sedimentary rocks of Mesozoic and Cenozoic age, lies in the Bison Basin area north of the Great Divide Basin. To the northeast, the Great

Divide Basin is bordered by the Precambrian, Paleozoic, Mesozoic, and Cenozoic rocks of Green Mountains and Crooks Mountain, and to the north of these are the Precambrian rocks of the Granite Mountains.

The Tertiary sedimentary rocks of the Great Divide Basin consist predominantly of lacustrine and fluviatile sandstone, siltstone, claystone, and shale. Coal beds and volcanic effusive material are also found in parts of the Tertiary section.

Quaternary deposits consisting of fluviatile, lacustrine, alluvial, colluvial, and eolian material are widespread in the Great Divide Basin, in many areas obscuring the earlier geologic record.

No single structural feature, such as a prominent basin or uplift, dominates the Great Divide Basin; rather, it is a region of relatively minor structural elements. Structurally, it may be a part of the Washakie Basin to the south (King, 1944). Major structural uplifts form the other boundaries of the basin:—the Rocks Springs anticline to the west, the Wind River uplift to the northwest, the Sweetwater uplift to the north and northeast, and the Rawlins uplift to the east. Northeastward-trending normal faults are common at the western edge of the basin along the flank of the Rock Springs uplift. Along the east side of the basin, faults are associated with the Rawlins uplift. Many faults occur along the north side of the basin around the nose of the Wind River Range and along the Green Mountains-Crooks Mountain area. In general, the major part of the basin south of the Lost Creek area is characterized by gentle folds and a minor amount of faulting, whereas the Lost Creek area in the northern part of the basin is characterized by more complex folding and by faulting. Faults in the Lost Creek area are probably related structurally to the Continental fault, mapped by Nace (1939), to the northwest of the Lost Creek area.

The regional geology is shown on maps by Love, Weitz, and Hose (1955), by King (1944), and in reports currently being prepared by G. N. Pipiringos and Harold Masursky. Regional structural features have been summarized by Eardley (1951, p. 362–374).

STRATIGRAPHY

Sedimentary rocks exposed in the Lost Creek area comprise a fluviatile and lacustrine sequence that ranges in age from Paleocene to Miocene and have an aggregate thickness of about 5,200 feet. A mantle of alluvium, colluvium, and stream terrace material of Quaternary age covers most of the area.

The sequence of Tertiary sedimentary rocks may be divided into six formations. The oldest is the Fort Union formation of Paleocene

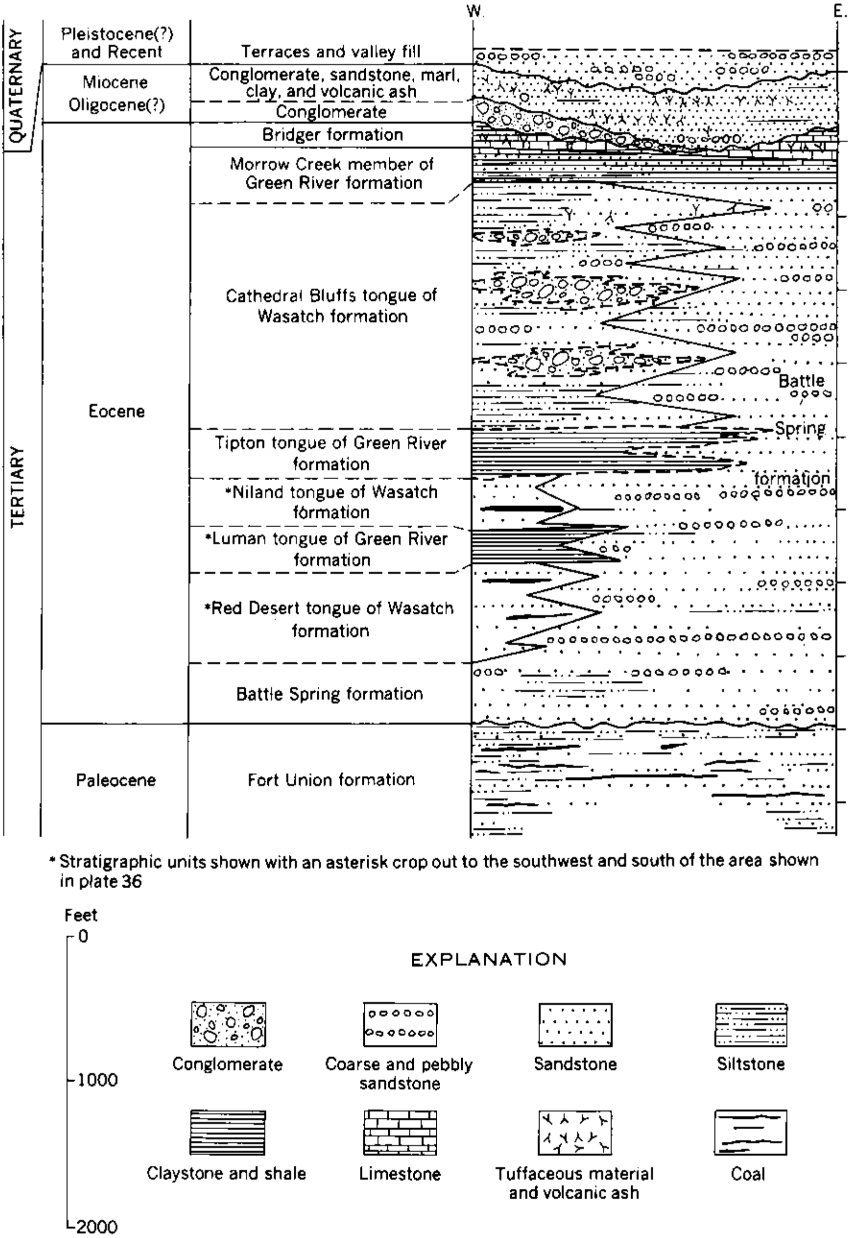

FIGURE 29.—Generalized diagram showing age and intertonguing relationships of formations in the Lost Creek area.

age. Unconformably overlying the Fort Union formation is an intertonguing sequence assigned to the Wasatch, Green River, and

Battle Spring formations of Eocene age. Above this intertonguing sequence is the Bridger formation of Eocene age. Boulder and pebble conglomerates of Oligocene (?) age, and conglomerate and tuffaceous sandstone of Miocene age overlie the Eocene formations.

Older sedimentary rocks that range in age from Pennsylvanian to Late Cretaceous are exposed on the western, northern, and eastern margins of the Great Divide Basin and probably underlie the Lost Creek area at depth.

The distribution of the various rock units in the Lost Creek area is shown by the areal geologic map, plate 36. The age and relative stratigraphic positions of the various formations, and the intertonguing relations of the Green River formation in the Lost Creek area, are shown on figure 29.

The distribution of the major Eocene units and of the thicker Quaternary deposits is shown in relation to topography on the geologic map and cross sections of the Lost Creek schroeckingerite area and vicinity (pl. 37). Maps of larger scale (pl. 38) indicate more detailed features of the stratigraphy in the exploration areas. The relative locations of the mapped areas shown on plates 36 and 38 are indicated on the index on plate 37.

Detailed features of parts of the Green River, Wasatch, and Battle Spring formations are shown in the geologic sections of trenches excavated by the U.S. Geological Survey (pls. 39–41).

ROCKS OF PALEOCENE AGE

FORT UNION FORMATION

The Fort Union formation was named by Meek and Hayden (1861, p. 433) for a sequence of sedimentary rocks exposed near old Fort Union, now Buford, N. Dak. Ball (1909, p. 249) applied the name in the Great Divide Basin to rocks of similar lithologic character that underlie the Wasatch formation of Eocene age and overlie the Lance formation of Late Cretaceous age.

The Fort Union formation is about 1,000 feet thick in Bison Basin north of the mapped area (W. G. Bell, 1954, p. 1371); the upper 50 feet is exposed in the Lost Creek area. The formation crops out in the northern part of the area along the northern branch of the Continental Divide. It consists predominantly of interbedded buff to gray massive coarse- to fine-grained sandstone, buff and gray shale, and siltstone. Some of the sandstone beds contain lenses of pebble conglomerate. Many thin beds of lignite crop out in the upper part of the formation, and the top is commonly marked by a resistant bed of platy ferruginous sandstone. No detailed study of the Fort Union formation was made, but its distribution is indicated on the geologic map.

Vertebrate fossils of Paleocene age were found by Wallace Bell (oral communication, 1953) just north of the area of plate 36.

ROCKS OF EOCENE AGE

The Eocene rocks in the Great Divide Basin include the Battle Spring, Wasatch, Green River, and Bridger formations, totalling about 4,200 feet in thickness, and consisting of sandstone, siltstone, oil shale, clay shale, limestone, conglomerate, and coal beds. Eight stratigraphic units have been recognized in the sequence underlying the Bridger formation (Pipiringos, 1955, p. 100–103; 1956, p. 434–435). Three are made up predominantly of claystone, siltstone, and sandstone with subordinate amounts of shale and coal; from oldest to youngest, they are the Red Desert, Niland, and Cathedral Bluffs tongues of the Wasatch formation. Grading into and intertonguing with these are four units consisting predominantly of paper shale with subordinate amounts of sandstone, siltstone, and limestone. From oldest to youngest, they are the Luman and Tipton tongues and the Laney shale and Morrow Creek members of the Green River formation. These units grade laterally into and intertongue with the coarse arkosic sandstone of the Battle Spring formation (Pipiringos, 1955, p. 101). The complex intertonguing relationships of these units are diagrammatically shown on figure 29 and by Pipiringos (1955, p. 101; 1956, fig. 148).

In the Lost Creek area, the representatives of the Eocene rock units are, in stratigraphic sequence from oldest to youngest: the Battle Spring formation, the Tipton tongue of the Green River formation, the Cathedral Bluffs tongue of the Wasatch formation, the Morrow Creek member of the Green River formation, and the Bridger formation.

BATTLE SPRING FORMATION

The Battle Spring formation was named by Pipiringos (1955, p. 103; 1956, p. 434) for a thick sequence of arkosic sandstone in the central part of the Great Divide Basin. This formation is made up of rocks formerly included in the Wasatch formation. They intertongue with all the subdivisions of the Wasatch and Green River formations as cited in this report. Figure 29 shows the generalized intertonguing relationships of the Battle Spring formation in the Lost Creek area. The inferred thickness of the Battle Spring formation is about 3,300 feet (Pipiringos, 1955, p. 103).

The Battle Spring formation consists of very coarse grained to pebbly arkosic sandstone, fine- to medium-grained arkosic sandstone, and conglomerate, with small amounts of green claystone containing angular fragments of quartz. It weathers into rounded slopes covered with feldspar fragments and sandstone and "ironstone" concretions. The formation is usually crossbedded and apparently is composed of delta deposits derived from the Granite Mountains to the north and northeast of the mapped area. Most of the eastern and northern part of the map area (pl. 36) is underlain by the Battle Spring formation. In much of the remaining area of Eocene rocks tongues of the Battle Spring formation intertongue with the Tipton tongue of the Green River formation and the Cathedral Bluffs tongue of the Wasatch formation.

One stratigraphic section of part of the Battle Spring formation, as exposed in trench 13, is described on pages 471–472.

WASATCH FORMATION

The Wasatch formation was named by Hayden (1869, p. 191) for a sequence of variegated sand and clay beds west of Fort Bridger, Wyo. Sears and Bradley (1924, p. 24) applied the name to rocks in the southern part of the Great Divide Basin. They divided the Wasatch formation into the main body below the Tipton tongue of the Green River formation and the Cathedral Bluffs tongue above the Tipton tongue (1924, p. 98–99). The part of the Wasatch formation that lies below the Tipton tongue of the Green River formation was named the Hiawatha member by Nightingale (1930, p. 1023). It is, in part, the same sequence of sedimentary rocks as the main body of the Wasatch, as described by Sears and Bradley (1924).

Pipiringos (1955, p. 100–103; 1956, p. 434–435) divided the Wasatch formation in the Great Divide Basin area into three units: the Red Desert tongue, unconformably overlying the Fort Union formation and underlying the Luman tongue of the Green River formation; the Niland tongue between the Luman and Tipton tongues of the Green River formation; and the Cathedral Bluffs tongue, overlying the Tipton tongue of the Green River formation. The thickness of the Wasatch formation is subject to considerable variation but is generally about 2,500 feet. The only representative of the Wasatch formation exposed in the Lost Creek area is the Cathedral Bluffs tongue.

CATHEDRAL BLUFFS TONGUE

The Cathedral Bluffs tongue, as named by Schultz (1920, p. 28–29), was included in the Green River formation. Sears and Bradley (1924, p. 98–99) and Sears (1924, p. 276, 293) placed the Cathedral Bluffs tongue in the Wasatch formation, in its present usage. Bradley (1926, p. 122) applied the name to the tongue in northern Sweetwater County, west of the Lost Creek area.

The Cathedral Bluffs tongue, together with the intertonguing Battle Spring formation, forms a persistent unit in the central part of the Lost Creek area where it occurs on the south limb of a synclinal structure (pls. 36 and 37). The intertongued unit is about 1,650 feet thick in the Lost Creek area and forms the host rock for almost all of the schroeckingerite mineralization. The Cathedral Bluffs tongue lies between the Tipton tongue and Morrow Creek member of the Green River formation. The stratigraphic relations are shown on figure 29.

In the Lost Creek area the intertonguing sequence of the Cathedral Bluffs tongue and Battle Spring formation consists of interbedded green and maroon variegated claystone; green, gray, buff, and brown claystone and siltstone; green, gray, and buff fine-grained sandstone; and buff to white, medium- to coarse-grained sandstone and pebbly sandstone. Most of the sandstone beds are poorly indurated and friable, although a few contain irregular and concretionary cemented lenses. Most of the medium- to coarse-grained and pebbly sandstone beds and a few of the fine-grained sandstone beds are arkosic. The claystone and silty claystone beds are blocky to subfissile, but there are a few beds of green, brown, gray, and bright maroon shale. Remains of volcanic shards are visible in some specimens, and much of the claystone and shale can be classified as bentonitic. In general, the claystone and siltstone and some of the fine-grained sandstone beds belong to the Cathedral Bluffs tongue, and the coarse arkosic sandstone and some of the claystone beds belong to the Battle Spring formation. No attempt was made to distinguish between the two units in this complexly intertongued area. Arbitrary facies lines were placed on the map (pl. 36) at the points where major transitions from Cathedral Bluffs tongue to the intertongued sequence and from the intertongued sequence to the Battle Spring formation were indicated.

Most of the individual beds in the intertongued unit are lenticular, and can be traced for only a few hundred feet. Typical examples of lenticular beds are illustrated in some of the large-scale geologic sections (pls. 39, 40, and 41). There are many abrupt changes in lithologic character, such as a claystone bed between two coarse pebbly sandstone beds (pl. 40, south end of section *S–T*). The lenticularity and abrupt changes in the size of sedimentary particles in adjacent beds at many places indicate a complex depositional history.

In most places where the Cathedral Bluffs tongue is present, including the type locality at Cathedral Bluffs, west of Wamsutter, it consists of gray siltstone banded with red and pink layers of clay. The red clay washes out and coats the rest of the formation, giving the impression that it is all red. The name Red Desert was derived from this coloration in the Cathedral Bluffs tongue. The red-clay bands become less numerous near the edges of the basin of deposition.

Four measured stratigraphic sections of parts of the intertongued sequence of Battle Spring formation and Cathedral Bluffs tongue in the Lost Creek area are described on pages 460–471. Except where specifically mentioned to the contrary, all sandstone beds described in the sections are poorly indurated and relatively friable. Most of them are arkosic with the exception of some of the silty sandstone and the fine-grained sandstone. Many of the beds do not persist laterally with uniform thickness owing to their lenticularity. Corrections for faulting were made wherever possible.

GREEN RIVER FORMATION

The Green River formation was first named the Green River shales by Hayden (1869, p. 89–92) for the sequence of thinly laminated shale beds near Green River, Wyo. The formation was divided into four members, from oldest to youngest: the Tipton tongue and the Laney shales, named by Schultz (1920, p. 27–28, 30), the Tower sandstone lentil (Powell, 1876, p. 45, 63), and the Morrow Creek member (Bradley, 1926, p. 123). Pipiringos (1955, p. 100–103) divided the Green River formation in the central part of the Great Divide Basin into four units. They are, from oldest to youngest: the Luman and Tipton tongues and the Laney shale and Morrow Creek members. The Green River formation covers an area of more than 25,000 square miles, with an average thickness of about 2,000 feet (Bradley, 1929, p. 88). The formation is made up of fresh-water lake deposits, light-gray, buff, and brown, varved and thin-bedded marlstone, oil shale, oolitic limestone and bedded algal deposits. Fossil fish, plants, gastropods, and ostracodes are common. Locally limy sandstone or sandy marlstone make up facies of the formation (Bradley, 1945).

Bradley (1945) described the generalized stratigraphic relations of the Green River formation in the following words:

> In the broadest and simplest terms the Green River formation is a huge lens of relatively fine-grained, generally calcareous, lake sediments embedded in a thick body of fluviatile sandy mudstone that formerly filled a huge intermontane basin. . . . The mudstone is divided into two formations: 1) the Wasatch formation, below the lens of Green River formation, and 2) the Bridger formation above. The sedimentary history of the intermontane basin was complicated, however, by changes in the level of the lake, which resulted in an intertonguing relationship between the Wasatch and the overlying Green River. . . .

The Tipton tongue and the Morrow Creek member are the only parts of the Green River formation exposed in the Lost Creek area.

TIPTON TONGUE

The Tipton tongue is the central subdivision of the Green River lake deposits. It is present over most of southwest Wyoming, as a major unit of the Green River formation. Bradley (1926, pl. 59) and Pipiringos (1955) described the general stratigraphic relationship of the Tipton tongue to the other formations in various parts of the Green River Basin.

In the Lost Creek area the Tipton tongue is near its northeastern limit of deposition, within the area of shoreline fluctuation, and is made up of several lenticular extensions, which interfinger with the Battle Spring formation. Only one "tongue" is exposed in the exploration area. One or more tongues may be present south of the exploratory trenches within the area of plate 36, but thick overburden prevented accurate mapping of the tongues. They were mapped together with the Battle Spring formation as an undifferentiated unit. On the geologic maps, plates 36 and 37, the upper contact of the extension of the Tipton tongue forms the contact of the undifferentiated unit.

Plate 38 shows the configuration of the Tipton tongue in the exploration areas. This shale tongue is 53 feet thick in trench 1 (pl. 39), 52 feet thick in trench 12 and 20 feet thick in trench 13 (pl. 41), showing a general thinning toward the east. It consists predominantly of thin-bedded, lamellar, and subfissile, brown and gray-brown shale, with lesser amounts of brown-green, gray-green, and yellow-brown shale and subfissile claystone, and a few thin beds of tan to cream-colored, waxy, bentonitic claystone, pale-green bentonitic claystone, and gray to brown-white sandstone. Locally, parts of the shale contain limestone concretions and nodules, 0.5 inch to 5 inches in diameter. In a few exposures, thin discontinuous seams of lignite as much as 1 inch thick are interbedded with the shale.

Some of the beds in the Tipton tongue in the exploration area are persistent enough to be used for local correlation across faults in the trenches and from trench to trench. It was not possible to obtain perfect correlation of all the subdivisions of the Tipton tongue sequence from trench to trench, because some of the exposures in the trenches are incomplete and some of them are complexly faulted. Although no sharp erosional channels were observed at the contact of the Tipton with the overlying Cathedral Bluffs tongue, the local absence of some of the subdivisions in the Tipton sequence can probably be explained by local unconformities at the top of the Tipton.

The only complete exposures of the extension of the Tipton tongue in the mapped area are in trenches 1, 12, and 13. An incomplete section of this "tongue" in trench 3 is 70 feet thick—thicker than any of the other exposures. This thickening may have been an original sedimentary feature, or it may be an apparent thickening caused by erosion of the upper part of the Tipton elsewhere in the area. It could also be caused by undetected faults in the shale beds, but corrections for known faults were made in calculating the thickness.

The Tipton tongue was exposed in trenches 1, 3, 4, 6, 8, 12, and 13 (pls. 39, 40, and 41). Details of the stratigraphy were recorded only in trenches 3, 8, 12, and 13, as shown by stratigraphic sections on pages 472–474. A stratigraphic section of undifferentiated beds of intertonguing Tipton tongue of the Green River formation and Battle Spring formation is described on page 459. It lies immediately below the stratigraphic section of the extension of the Tipton tongue as exposed in trench 12 and described on page 473.

Several sets of fossils from the Green River formation were collected in the Lost Creek area. At fossil locality 1 (pl. 36 and pl. 40, geologic section *D–E*) in trench 3 the following fossils were obtained from the brown shale of the upper extension of the Tipton tongue: *Mioplosus* cf. *beani*, *Phareodus* sp?, and a matted mass of smooth ostracode valves. *Mioplosus* cf. *beani*, a fish from the Green River formation, is illustrated in figure 30. At fossil locality 4 (pl. 36) a coquina layer in

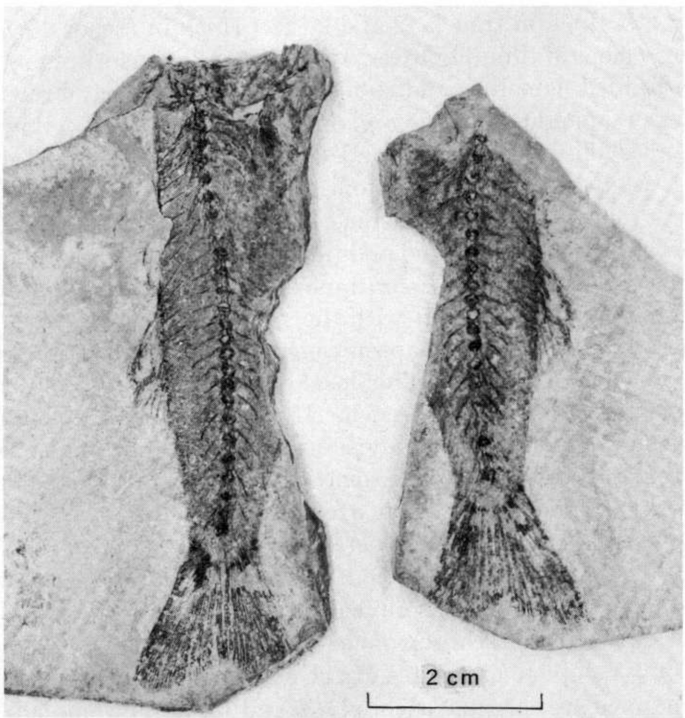

FIGURE 30.—Fossil fish, *Mioplosus* cf. *beani*, in brown shale of the Tipton tongue, Green River formation (fossil locality 1, pl. 36; pl. 40; table 1).

brown shale contains abundant ostracodes. Data on these ostracodes and the fossils listed above are given in table 1.

TABLE 1.—*Paleontologic data, Lost Creek area, Sweetwater County, Wyo.*

[Identification of fossil fish remains by D. H. Dunkle, algae by Richard Rezak, mollusks by J. B. Reeside Jr., ostracodes by I. G. Sohn]

Fossil locality (pl. 36)	Fossils	Specimen No.	Stratigraphic position [1]	Remarks
FL-1 [2]	*Mioplosus* cf. *beani*, *Phareodus* sp.?, and smooth ostracode valves.	DS-F-1, DS-F-2, DS-F-3, DS-F-6, DS-F-4.	In the Tipton tongue of the Green River formation, in brown shale 27 ft below the top of an incomplete section totalling 70.2 ft in thickness.	Fossil fish, (*Mioplosus* cf. *beani*) reported by Dunkle as of Green River age. Matted mass of ostracode valves, all flattened, not the same species as that in collection by G. N. Pipiringos from Tipton tongue 5 miles northeast of Tipton, but difference in species probably due to difference in ecology. Stratigraphic section described on pages 472–473.
FL-2	*Unio shoshonensis* White, and *Goniobasis nodulifera* Meek.	DS-F-7 and DS-F-8.	In a well-cemented sandstone bed 32.3 ft below the top of the Morrow Creek member of the Green River formation.	This section of the Morrow-Creek member is 238.8 ft thick (p. 474–475).
FL-3	*Australorbis spectabilis* (Meek).	DS-F-9	In lower part of the Bridger formation.	No stratigraphic section was measured at this locality.
FL-4	Ostracodes	DS-F-10 and DS-F-11.	In coquina layer in brown shale of the Tipton tongue of the Green River formation.	Ostracodes are very similar in shape and size to *Cyprois* cf. *C. marginata* (Strauss) as identified by Swain (1949, p. 177, pl. 32, fig. 14) from the Flagstaff member of the Wasatch formation, 1 mile west of Ephraim, Utah.
FL-5	*Chlorellopsis coloniata* Reis, with thick covering layers of *Rivularia*-like mats.	DS-F-12	In a limestone bed, the uppermost bed of the Morrow Creek member of the Green River formation, containing algal structures.	Stratigraphic section described on pages 474–475.
FL-6	*Chlorellopsis coloniata* Reis, with covering layers of *Rivularia*-like mats.	DS-F-13	In the same type of bed and at the same stratigraphic horizon as fossil locality 5.	
FL-7	Laminated algal structures suggestive of the form genus *Collenia*.	DS-F-14	In a 1-ft bed of pale-green-yellow calcareous claystone in the Bridger formation.	Although no stratigraphic section was measured at this locality, the equivalent claystone bed is cited in the stratigraphic section on page 475, 197 ft above the base of the Bridger formation.

[1] None of the fossils collected for this report is diagnostic for specific locations in the stratigraphic column, except that they all are reported to be Eocene in age. The stratigraphic positions represent the positions within the various Eocene units as mapped by the authors.

[2] Location also shown on section *D–E* of plate 40.

MORROW CREEK MEMBER

The Morrow Creek member was named by Bradley (1926, p. 23, and pl. 59) for the sequence of lacustrine sedimentary rocks at the top of the Green River formation. It is a distinct lithologic unit that, in the Lost Creek area, overlies the Cathedral Bluffs tongue of the Wasatch formation and the Battle Spring formation and underlies the Bridger formation (fig. 29).

The Morrow Creek member in the Lost Creek area is about 240 feet thick and is characterized by a series of well-cemented, gray to brown, white-weathering sandstone beds with cement, in part silica and in part carbonate. Some of the sandstone beds are arkosic. Between the well-cemented sandstone beds are brown-white friable sandstone and gray, green, and brown-gray siltstone and claystone. Some of the claystone and siltstone beds contain limestone nodules.

The Morrow Creek member extends from the western boundary of the area shown on the geologic map (pl. 36) southeastward along the southern limb of a syncline, curves around the southeastern nose of the syncline and northwestward along the northern limb of the syncline. Pipiringos (oral communication, 1954) has traced the same sequence farther to the west.

The designation of the Morrow Creek member in the Lost Creek area was based largely on lithologic characteristics. The base of the Morrow Creek was arbitrarily assigned to a thin, well-indurated sandstone bed, which overlies a green claystone bed at the top of the Cathedral Bluffs tongue. The top of the member was assigned to a limestone bed containing characteristic lobate algal structures. These lobate structures are *Chlorellopsis coloniata* Reis, with thick covering layers of *Rivularia*-like mats (FL–5, FL–6, pl. 36; table 1). A well-cemented sandstone bed 33 feet below the top of the Morrow Creek is irregularly fossiliferous along strike; it contains *Unio shoshonensis* White and *Goniobasis nodulifera* Meek (FL–2, pl. 36; table 1). None of these fossils are diagnostic; they are useful only in local correlation of beds.

The stratigraphic section of the Morrow Creek member described on pages 474–475 is located east of Lost Creek on the south limb of the syncline (pl. 37).

BRIDGER FORMATION

The Bridger formation was named by Hayden (1869, p. 191) for a series of rocks near old Fort Bridger, Wyo. It consists, in various parts of southwest Wyoming, of poorly consolidated lenticular beds of sandstone, gray and green-gray clay, shale, mudstone, volcanic ash beds, and light-gray marlstone, limestone, and chert beds. The base of the Bridger is indistinct; the rocks of the Bridger formation grade into the rocks of the underlying Morrow Creek member of the Green River formation (Sears and Bradley, 1924, p. 95). The Bridger commonly weathers into pronounced badlands and the beginning of the badlands type of weathering is usually drawn as the base (Bradley, 1926, p. 123).

The authors mapped a sequence of rocks about 245 feet thick in the Lost Creek area as the Bridger formation, largely on the basis of lithologic similarities with parts of the formation exposed elsewhere in Wyoming. The Bridger sequence in the Lost Creek area is characterized by interbedded limestone and friable biotitic sandstone. Some of the limy beds are argillaceous and siliceous. Many of the beds contain abundant volcanic material. A thin section of one bed of carbonate-cemented fine-grained sandstone contained abundant remnants of shards. According to Sinclair (1906), almost the entire Bridger formation is of volcanic origin—tuff and tuffaceous shale, sandstone, and marl.

On the geologic map, plate 36, the Bridger formation extends from the western boundary southeastward along the southern limb of a syncline. On the east side of Lost Creek the Bridger forms the entire central part of the syncline. Love and others (1955) also show the Bridger formation in a similar pattern in the Lost Creek area. Pipiringos (oral communication, 1954) has traced the same sequence farther to the west. The authors have mapped the base of the Bridger as immediately overlying the characteristic algal horizon, which occurs at the top of the Morrow Creek member of the Green River formation. The upper part of the Bridger sequence in the Lost Creek area is truncated by an unconformity. In the western part of the area the Bridger sequence is overlain by conglomerate of Oligocene(?) age and in the central part of the area it is overlain directly by tuffaceous sandstone of Miocene age. The general stratigraphic relations of the Bridger formation in the Lost Creek area are shown on figure 29.

Fossils found in the Bridger formation in the Lost Creek area include *Australorbis spectabilis* (Meek) and some laminated algal structures suggestive of the forms genus *Collenia* (table 1). Some of the limy beds contain abundant ostracodes.

The stratigraphic section described on pages 475–476 is located just east of Lost Creek on the southern limb of the syncline.

ROCKS OF OLIGOCENE(?) AGE

To the west of Lost Creek along Cyclone Rim, a series of boulder conglomerate beds is separated by unconformities from the Bridger formation below and from the Miocene rocks above. This conglomerate unit may be equivalent to the Bishop conglomerate, or the lower part of the Browns Park formation, both of Miocene(?) age. However, because of the proximity and lithologic similarity to the lower part of the White River group just north of the mapped area, it has been designated as Oligocene(?), correlative with the similar conglomerate of the White River (Bauer, 1934).

The conglomeratic section was not measured, but the thickness along Cyclone Rim to the west is about 100 feet. It thins abruptly toward the east and disappears about 1¼ miles west of Lost Creek. The conglomerate is composed of boulders and pebbles of crystalline igneous and metamorphic rocks, with sandstone and quartzite in a fine to granular quartz-sand matrix.

In an area about 25 miles west of Lost Creek, Nace (1939) described and named a sequence of coarse detrital rocks above the Bridger formation the Continental Peak formation (Eocene), overlain by the Beaver Divide conglomerate member of Nace (1939) of the Chadron formation (Oligocene). Most of the sequence mapped in the Lost Creek area as Oligocene(?) rocks directly overlies sedimentary rocks similar to those of the Bridger formation and has a lithologic similarity to that of Nace's Beaver Divide conglomerate.

ROCKS OF MIOCENE AGE

Above the Oligocene(?) rocks in the Lost Creek area is a lenticular series of conglomerate and coarse-grained sandstone beds ranging in thickness from 0 to 100 feet followed by a sequence of tuffaceous sedimentary rocks ranging in thickness from about 40 feet, east of Lost Creek (pl. 36), to a probable maximum of about 400 feet, west of Lost Creek. This sequence of rocks is lithologically indistinguishable from beds of middle Miocene age in the vicinity of Split Rock (McGrew, 1951), about 20 miles northeast of the Lost Creek area. On the basis of this lithologic similarity, the sequence at Lost Creek was designated as Miocene by the authors. It may be equivalent to the Browns Park formation.

The base of the Miocene rocks in the Lost Creek area consists of conglomerate beds of variable thickness grading upward into gray and white coarse- to fine-grained sandstone beds, with lenses and thin beds of gray and green marl, clay, and volcanic ash. The basal conglomerate is present only in the area extending westward from Soda Lake (pl. 36). East of Soda Lake the basal conglomerate is absent and the sandstone rests directly on the Bridger formation.

Overlying the basal sequence is a thick series of pink, pinkish-gray, and gray, fine-grained sandstone, tuffaceous sandstone, and volcanic ash. Local unconformities occur within the formation, and an angular unconfirmity separates it from the underlying Oligocene(?) and Eocene rocks.

QUATERNARY DEPOSITS

Quaternary deposits consisting of fluviatile, lacustrine, alluvial, colluvial, and eolian sediments overlie much of the Tertiary bedrock in the Great Divide Basin. In some parts of the basin the sites of Pleistocene lakes are indicated by broad shallow depressions. During Pleistocene and Recent time a number of extensive terraces, both depositional and erosional, were formed, whose remnants are still discernible over most of the Great Divide Basin.

There are at least eight levels of terracing in the Lost Creek area, two that are probably Recent. No attempt has been made to delineate these terraces or to evaluate the geomorphic significance of the surfaces.

The varied character and distribution of the Quaternary sediments indicate a complex physiographic history since Tertiary time. Because the deposits are complex in detail and the exact age of much of the surficial material is indeterminate, the surficial deposits in the Lost Creek area were not differentiated as Pleistocene and Recent but are shown on the various illustrations simply as Quaternary deposits. Only the thickest deposits and some of the prominent high terraces, some that are capped by conglomerate beds, are shown on the geologic maps (pls. 36 and 37). Much of the remaining area, shown as Tertiary bedrock, is actually mantled by Quaternary overburden. The presence of thin overburden over much of the area is indicated by the many concealed contacts and concealed faults shown on plate 38.

The sites of deposition and erosion probably shifted frequently in Pleistocene and Recent time. Many examples of old channel sands were found in the surficial material. In some places the thickest alluvium occurs on topographic highs, indicating that the present erosional pattern has shifted from preceding patterns.

The lithologic character of the Quaternary deposits in the Lost Creek area is extremely varied. Along Lost Creek and its tributaries the alluvium and colluvium are predominantly gray-brown sandy clay and silty clay, with irregularly distributed coarse pebbly sand lenses, representing the former sites of stream channels. The maximum thickness of the alluvial deposits along Lost Creek could not be determined but is probably more than 8 feet. In the parts of the area away from present stream courses the Quaternary deposits are partly alluvial and partly colluvial, and they range in thickness from 6 inches to over 8 feet.

An unconformity at the base of the alluvium and colluvium of Quaternary age truncates the northward-dipping Eocene strata in the exploration area. In cross section the unconformity ranges from a relatively smooth, regular surface, as in trench 2 (pl. 40) to a very irregular, complexly channeled surface, as in part of trench 1 (pl. 39, geologic section *A–B*). Near the south end of trench 9 (pl. 41) irregular erosional remnants of claystone in the Cathedral Bluffs tongue of the Wasatch formation occur in the Quaternary alluvium; elsewhere in trench 9, sharp erosional channels were cut in other claystone and sandy claystone beds in the Cathedral Bluffs tongue.

SOURCE OF SEDIMENTS

All of the sediments in the Lost Creek area seem to have originated from the north. The Paleocene sediments were apparently derived mostly from the ancestral Sweetwater mountains—the Sweetwater arch, which was a prominent positive area during Late Cretaceous and early Tertiary time. The Wind River Range, about 20 miles northwest of the Lost Creek area, probably furnished much of the middle Eocene sediments carried into the area, for it contains considerable coarsely crystalline granite; the middle Eocene stream-channel deposits contain fresh and angular grains and are generally arkosic, suggesting that they probably came from the Wind River Range. Blackwelder (1915) indicated that the Wind River Range was sufficiently high above the basin of deposition during Eocene time to furnish abundant rock waste to the basin. The relationship between the Wasatch and Green River formations also indicates that the source of sediments was to the north. These formations interfinger in such a way that the fluviatile sediments of the Cathedral Bluffs tongue of the Wasatch formation thin or disappear to the south and the lacustrine sediments of the Green River formation either thin or disappear entirely to the north. The Morrow Creek member of the Green River formation becomes more sandy and thins northward and rests directly on the Cathedral Bluffs tongue (Bradley, 1926, p. 125).

At the beginning of deposition of sediments of the Bridger formation there was further active erosion and sedimentation and considerable volcanic activity. The sources of the sediments for this sequence and the Oligocene(?) and Miocene sequence were not determined in the Lost Creek area, but were probably also from the north.

STRUCTURE

The major structural features of the Lost Creek area are a northwestward trending syncline, a northwesterly set of faults, and a northeasterly set of faults. A long curving fault occurs along the north flank of the syncline and has a displacement of at least 2,500 feet. The northwestward-trending Cyclone Rim zone of faulting occurs along the southern limb of the syncline; the net stratigraphic displacements in most places along this zone are less than 400 feet. Much of the faulting may be either Miocene or post-Miocene in age. The northwesterly faults in the Lost Creek area probably are part of a major regional fault system that extends at least 75 miles across southwestern Wyoming.

The general structural features are shown on plate 36, and more detailed structural features and the topography are shown in relation to the area of schroeckingerite mineralization on plate 37. Typical features of complex faulting in the Cyclone Rim zone are illustrated on the large-scale surface maps (pl. 38) and in the geologic sections of some of the trenches (pls. 39–41).

FOLDS

The most prominent structural feature in the Lost Creek area is a syncline that trends approximately N. 60° W. (pls. 36 and 37). The structure of the syncline is relatively simple in the central and southeastern parts of the mapped area. The dips range from 4° to 53°. The fold is slightly asymmetric with the more steeply dipping limb on the southwest side. In the northwestern part of the area the syncline either flattens out or is cut off by the complex faulting. The diverse orientation of beds north and northwest of Soda Lake may indicate minor cross structures subordinate to the major fold or may be, in part, a result of the faulting.

The general strike of the beds in the mineralized area on the southern limb of the syncline is about N. 60°–75° W. and the average dip is about 22° NE. In detail, however, the strike and dip of the beds range considerably (pl. 38). The local departures from the general trend are caused in part by the extreme lenticularity of beds and in part by complex faulting.

Anticlines along the southern margin of the area are relatively minor structural features and are typical of the gentle folding that is characteristic of the major part of the Great Divide Basin to the south of the Lost Creek area.

FAULTS

The Lost Creek area is cut by many faults that range widely in attitude and in magnitude of displacement. Detailed information on some of these faults was obtained during mapping of the trenches, but a complete areal study of the fault pattern was not possible in the time available. A generalized interpretation of the fault pattern, however, was made possible by the data from exploratory openings, the stratigraphic data from studies of outcrops, and the study of persistent linear elements on aerial photographs.

DESCRIPTION OF FAULTS

From the geologic map (pl. 36), it can be seen that the major faults can be classified as a northwesterly set and a northeasterly set. The northwesterly set of faults is subparallel to the long axis of the syncline. Detailed data for many of the faults are not available because Quaternary deposits form a persistent mantle over much of the area. At least one of the main fault trends is known to be a zone of faulting—the Cyclone Rim zone. Some of the other fault lines shown on plate 36 also may represent zones of faulting rather than individual fault planes.

The largest fault in the Lost Creek area belongs to both sets of faults. This major fault extends from the northwestern corner of the area southeastward along the northern limb of the syncline. In the eastern part of the area the fault trends northeastward to parallel the faults with a northeastward trend. The total length of this fault is at least 16 miles. West of Flat Top Mountain in the northwestern part of the area, the north side of the fault is upthrown, bringing beds of the lower part of the Battle Spring formation into fault contact with tuffaceous sandstone of Miocene age. The stratigraphic displacement in this part of the area is at least 2,500 feet and possibly as much as 4,000 feet. The amount of displacement may decrease toward the east. The dip of the fault plane could not be determined, and parts or all of this major structure actually may be a zone of faulting rather than a discrete fault.

The Cyclone Rim zone of faulting extends along the southern limb of the syncline parallel to the northwestern part of the large fault along the northern limb of the syncline. This zone of faulting lies south of and parallel to the local topographic feature called the Cyclone Rim. The zone was named and cited as an important structural feature by Wyant, Sharp, and Sheridan (1956, p. 243). It is about 14 miles long and trends N. 72° W. The northern and southern limits of the zone as shown on the small-scale geologic map (pl. 36), are arbitrary, and are drawn to include the major part of the complex faulting. The northwestern and southeastern extensions of the Cyclone Rim zone are shown as single fault lines because field data in those areas were less complete. A study of aerial photographs has suggested that the zone of faulting may extend even farther to the southeast. According to G. N. Pipiringos (oral communication, 1954) a study of stratigraphy to the northwest along a possible projection of the zone of faulting disclosed no major breaks in the section. It has been assumed, therefore, that the northwestern extension of the Cyclone Rim zone terminates as shown—possibly losing its identity along the bedding planes in the Cathedral Bluffs tongue. A group of minor faults, previously described by Wyant and others as being part of the fault zone, occurs about three-fourths of a mile north of the northwestern extremity of the zone. According to the present interpretation, these minor faults lie outside the main zone and have been omitted from plate 36, along with similar minor faults elsewhere in the mapped area.

On the geologic map of the Lost Creek schroeckingerite area (pl. 37), the arbitrary limits of the Cyclone Rim zone of faulting are omitted, and individual faults, both within the zone and extending outside it, are shown. The effects of the faulting are illustrated by the complexly broken contact between the Cathedral Bluffs tongue of Wasatch formation and Battle Spring formation undifferentiated and the Tipton tongue of Green River formation and Battle Spring formation undifferentiated. Typical of the complex fault relations are those in the area around trench 8 and trench 13 and those in the area between trenches 3 and 4. The data are incomplete in the large unexplored area between trench 12 and trench 13 and in the area northwest of trench 8, so that the fault patterns in these areas are somewhat diagrammatic. In general, the longer faults in the zone trend northeastward, but other faults in the zone trend in every conceivable direction.

The complexity of faulting in the Cyclone Rim zone is illustrated at a larger scale on plate 38. Faults and geologic contacts are shown as concealed because much of the area is covered by Quaternary deposits. Locations of the faults and contacts were determined partly by interpretation of aerial photographs and partly by projection of data from exploratory openings. The dips of the fault planes and the upthrown and downthrown sides are indicated, wherever such data were available from the exposures in the trenches.

Typical examples of some of the faults in the Cyclone Rim zone are illustrated in some of the large scale geologic sections (pls. 39–41). They include normal and reverse faults, that cut the bedding at various angles, and thrust faults and other faults of unknown relative movements, many that are parallel or subparallel to the bedding. True displacements could not be measured accurately because data are incomplete in the large intervals between trenches and because the extreme lenticularity of the beds in the intertonguing sequence of Cathedral Bluffs tongue of the Wasatch formation and Battle Spring formation causes difficulty in correlating units across faults. The apparent displacements are small, ranging from less than an inch to several hundred feet. Many of the fault planes are iron stained, and some of the larger faults are irregularly filled with clay gouge.

Normal faults are the most abundant of the various types of faults mapped in the trenches. A southward-dipping normal fault in the southern part of trench 8 (pl. 41, geologic section *A–B*) is accompanied by strong drag of shale beds of the Tipton tongue on the footwall side; the dip component of the displacement on this fault is about 150 feet. Farther north in this same trench a group of normal faults causes complex repetition of a sequence of beds of pebbly sandstone and claystone in the intertonguing Battle Spring formation and Cathedral Bluffs tongue; the net apparent displacement caused by this group of faults is only about 40 feet. A similar example of complex faulting with small displacements on individual faults is shown in the southern part of trench 6 (pl. 40, geologic section *O–P*). Some of the normal faults in the zone have a surprisingly low angle of dip. Typical examples, having dips of 22° to 27°, are in the southern part of trench 7 (pl. 40, geologic section *R–S*), in the southern part of trench 3 (pl. 40, geologic section *D–E*, above FL–1), and in the southern part of trench 4 (pl. 40, geologic section *G–H*). In trench 3 (pl. 40, geologic section *D–E* and trench 13 (pl. 41, geologic section *T–U*) normal faults have caused major repetition of the shale marker unit of the Tipton tongue. In trench 3 the apparent displacement on this southward normal movement is approximately 95 feet, and in trench 13 the apparent displacement is about 65 feet. Farther north in trench 13 (pl. 41, south end of geologic section *U–V*) is a series of four steeply dipping faults which, together, represent one of the strongest normal faults exposed in the zones; although the exact amount of displacement is not known, studies of aerial photographs suggest that the dip component of the displacement is approximately 200 to 300 feet.

An example of a reverse fault is shown in trench 3 (pl. 40, geologic section *D–E*) at the north end of the northernmost exposure of the Tipton tongue. This fault cuts the top of the Tipton tongue at a low angle to the bedding.

Thrust faults in the southern part of trench 3 (pl. 40, geologic section *D–E*) have caused small displacements in the beds of the Tipton tongue. An example of a thrust fault lying nearly parallel to the bedding is shown in trench 2 (pl. 40, geologic section *A–B*).

On the basis of preliminary geologic studies, Wyant, Sharp, and Sheridan (1956, p. 243) described the Cyclone Rim zone as en echelon faulting and interpreted it essentially as a high-angle northward-dipping thrust fault. On the basis of tentative correlation of stratigraphic units on opposite sides of the zone, they assumed an apparent stratigraphic displacement of 400 to 700 feet, with the north side upthrown.

The more recent exploratory work indicates that the fault pattern (pl. 37) in the Cyclone Rim zone is much more complex than simple en echelon faulting. Furthermore, the newer data indicate that stratigraphic units are in their proper sequence northward across the zone of faulting, and the only repetitions of units are on a minor scale within the zone. Presently available data indicate that the net stratigraphic displacements in most places along the zone are less than 400 feet; in no place along the zone is the overall displacement believed to be more than 700 feet. Instead of an overall movement downward on the south side of the zone, parts of the zone appear to be downthrown on the south side, whereas other parts appear to be downthrown on the north side. Examples of downward movement to the south are in the area along trench 3 (pl. 38) and in the area midway between trench 12 and trench 13 (pl. 37). Examples of movement downward to the north are in the trench 13 area and in the trench 8 area. These apparent displacements along the zone may represent a series of scissors movements.

Despite the small net displacements along the Cyclone Rim zone of faulting, the prominent trend and extent of the zone and the complexity of faulting are probably indicative of a major fault at depth. The overall net movement of such a fault at depth probably is downward on the north side, because near-surface evidence near the eastern and western ends of the trenched area indicate such movements. Pipiringos (1956, p. 436) has also interpreted the movement on this fault—the Cyclone Rim zone of faulting of the present report—as downward on the north side, with a maximum inferred displacement of about 200 to 300 feet.

In addition to the long northwesterly faults on the northern and southern limbs of the syncline, other long faults in the Lost Creek area trend northeasterly. The longest follow Lost Creek and Arapahoe Creek in the northeastern part of the area. Additional northeasterly faults of shorter length occur in the north-central part of the area and in the central and eastern part of the syncline north and east of Osborne Draw.

AGE OF FAULTS

The relative ages of faults are not always related closely to their geographic directions, and data from outside the Lost Creek area suggest that repeated movement may well have occurred along some fault planes during several geologic intervals. The study of aerial photographs suggests that the long fault on the north flank of the syncline displaces the northeasterly fault that follows Lost Creek. But the long fault, in turn, is apparently displaced by the northeasterly fault that follows Arapahoe Creek.

The absolute age of faulting cannot be determined from the study in this Lost Creek area alone. Much of the faulting may be either Miocene or post-Miocene in age, as suggested by the relations of the major fault in the northwestern part of the area. From field studies in the vicinity of this major fault, G. N. Pipiringos (written communication, 1956) concluded that much of the movement occurred before deposition of the tuffaceous sandstone of Miocene age but that some

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movement occurred since the deposition of the Miocene unit. In the exploratory trenches none of the fault planes in the Eocene rocks could be traced upward into the Quaternary deposits. This suggests that the faulting in the Cyclone Rim zone occurred between Eocene and Quaternary time. On the aerial photographs, however, the physiographic terraces appear to be tilted in the vicinity of some of the linear fault trends; this suggests possible movement on some of the faults in the Pleistocene or Recent epochs.

RELATION TO REGIONAL STRUCTURE

The fault system in the Lost Creek area probably is related to the Continental fault, which was mapped by Nace (1939, p. 44–46, pl. 1.) in the region northwest of the Lost Creek area. On the Geologic Map of Wyoming (Love, Weitz, and Hose, 1955) Nace's Continental fault extends from the southeastern part of Sublette County to the vicinity of Picket Lake near the southern border of Fremont County; on this map the Continental fault is terminated by northeasterly faults southeast of Picket Lake.

The position of the northwestward-trending fault pattern in the Lost Creek area relative to the Continental fault pattern indicates that the two patterns together form a major regional fault system that extends at least 75 miles across southwestern Wyoming.

URANIUM DEPOSITS

Three types of uraniferous material have been found in the near-surface part of the Lost Creek area: schroeckingerite; other radioactive materials containing small amounts of uranium; uraniferous ground water. Schroeckingerite is the only uranium mineral that has been identified in the area.

The Lost Creek area contains the largest known concentration of schroeckingerite in the world. Schroeckingerite, a hydrated fluocarbonate-sulfate of sodium, calcium, and uranium, is distributed irregularly and sparsely in elongate lenticular deposits, most of which are in a zone 2 to 8 feet below the surface of the ground. The deposits are on the southern limb of a syncline and are partly within and partly north of the Cyclone Rim zone of faulting. The principal host rocks are beds in the intertonguing sequence of the Cathedral Bluffs tongue of the Wasatch formation and the Battle Spring formation. Most of the samples from the deposits contain less than 0.050 percent uranium. No production has been recorded, but the deposits constitute a large reserve of low-grade uraniferous material.

In addition to the schroeckingerite deposits, the Lost Creek area is characterized by abnormal concentrations of uranium in the ground water. Individual water samples contain as much as 46 parts per million in uranium.

In the same area as the schroeckingerite deposits are poorly defined deposits containing low-grade concentrations of uranium, but no schroeckingerite or other uranium mineral has been identified in them. Such deposits may represent sites of incipient mineralization by schroeckingerite or sites of former schroeckingerite deposits. Some of the iron-cemented sandstone and similar rocks in the Lost Creek area are also radioactive but the uranium content is very low.

The immediate source of the uranium for the schroeckingerite deposits is the uraniferous ground water. The deposits are epigenetic in character and, like other caliche-type deposits, are apparently deposited by simple crystallization from water. The most likely source of the uranium is in concealed uranium deposits in the Lost Creek area. These hypothetical source deposits probably are relatively high in grade compared with the schroeckingerite deposits.

SCHROECKINGERITE DEPOSITS

AREAL DISTRIBUTION

The approximate outline of the area that contains known deposits of schroeckingerite is shown on plate 37. This elongate area, about ½ square mile in size, is located on the east side of Lost Creek. The long dimension of the area trends N. 67° W. The northern part of the area is 8,800 feet long and the southern part is 10,000 feet long. Near the west central part of the area, the width is as much as 3,000 feet, but tonguelike extensions taper to the southeast and to the northwest.

The distribution of known deposits is indicated on plate 38. Wide deposits and areas of abundant small deposits along the trenches are indicated by series of closely spaced "X" symbols. The distribution of individual schroeckingerite deposits in trenches 1–12 is shown in detail on the geologic sections (pls. 39–41). The maps and geologic sections show irregular distribution along the trenches and along the lines of drill holes in the mineralized area. Additional deposits of schroeckingerite probably are distributed in a similar manner in the areas between exploratory openings.

VERTICAL RANGE

The vertical range of the deposits of schroeckingerite is from the ground surface to the level of the ground water. Most of the deposits are distributed irregularly in a zone 2 to 8 feet beneath the surface of the ground. The maximum depth of known deposits is 14 feet and no deposits were found below the level of the ground water in trenches or drill holes. It is entirely possible that additional deposits may occur at greater depths in the areas where the ground water level is fairly deep.

GEOLOGIC SETTING

The area containing schroeckingerite deposits is situated on the southern limb of the northwestward-trending syncline (pl. 37). The southern part of the mineralized area lies within the Cyclone Rim zone of faulting. Plate 36 shows that the general position of the schroeckingerite area (in the vicinity of the main group of trenches) is near the junction of the Cyclone Rim zone of faulting and the group of long northeasterly faults.

The majority of the schroeckingerite deposits are in Eocene sedimentary rocks, but some deposits occur partly or wholly within the Quaternary overburden. Most of the deposits occur in the intertonguing sequence of the Battle Spring formation and the Cathedral Bluffs tongue of the Wasatch formation. A few deposits also occur in the underlying Tipton tongue of the Green River formation (for example, trench 3, pl. 40).

SHAPE AND SIZE

Detailed information pertaining to the cross-section shapes and sizes of the schroeckingerite deposits was obtained in the U.S. Geological Survey trenches. Information from drill holes and older excavations is less complete but allows some inferences as to the third dimensional character of the deposits.

Most of the schroeckingerite deposits are elongate lenticular bodies, but some are irregular to branching in shape. In cross section the most common shape is the elongate lens which lies parallel or subparallel to the surface of the ground (trench 2, pl. 40, geologic section *A–B*; trench 10, pl. 41, geologic section *J–K*). Small rounded to elongate shapes are also fairly common (trenches 4, 6, 7, and 9, pls. 40 and 41). Less common are crudely tabular deposits that extend parallel or subparallel to the bedding of the Eocene rocks (southern part of trench 2, geologic section *A–B*, and trench 5, geologic section *M–N*, pl. 40). Some of the deposits are very irregular in cross section (trench 3, pl. 40, geologic section *E–F*). Drilling data from the vicinity of trench 1 suggest that many of the separate exposures in trench 1 (pl. 39) are probably connected to the southeast and northwest of the trench, forming elongate branching deposits with irregular barren areas.

Individual deposits range in thickness from 2 inches to about 7 feet, but the average thickness is about 1.5 feet. The thickest known deposit occurs in trench 5 (pl. 40, geologic section *L–M*), where an incomplete exposure extends 6.3 feet vertically from the unconformity at the base of the Quaternary overburden to the base of the trench.

Other individual deposits are as small as 0.5 square foot in cross section.

The width of individual deposits is commonly less than 10 feet, and the maximum width is probably 80 feet. The widest known deposit occurs in trench 2 (pl. 40, geologic section *A′–B′*), where a continuous exposure extends 41 feet along the trench. Small gaps between adjacent exposures in this vicinity are probably small barren areas within a larger deposit, so that a projection of the width can be made logically over a total distance of 80 feet.

Data on the lengths of individual deposits are less complete because the trenches were excavated at right angles to the general trend of elongation of the deposits. Combined data from drill holes, old excavations, and trench mapping in the vicinity of trench 1 suggest that the ratio of width to length is between 1 : 4.5 and 1 : 6.5. If it can be assumed that this ratio can be applied to deposits elsewhere in the mineralized area, then the majority of the deposits are probably less than 50 feet in length. The longest known deposit near Trench 1 extends about 390 feet, but it is irregular, with unknown gaps and barren areas totalling 100 feet in length.

RELATIONS TO LITHOLOGIC AND STRUCTURAL FEATURES

The schroeckingerite deposits are not limited to certain stratigraphic horizons, to particular lithologic units, or to particular bedding planes or fault structures, but, in general, the longest dimension of the deposits tends to be parallel or subparallel to the strike of the Eocene rocks. This general trend of the elongation of the deposits is about N. 60°–80° W. Relations to particular beds and bedding planes had been inferred previously (Wyant, Sharp, and Sheridan, 1956, p. 263–264) on the basis of the few exposures then available, but these restricted relations are now believed to be less common. The more extensive recent exploration has shown clearly that, in detail, most of the deposits lie subparallel to the surface of the ground, commonly overlapping the unconformity at the base of the Quaternary overburden and extending across bedding planes and fault planes in the Eocene rocks.

The deposits exposed in the trenches commonly extend across lithologic boundaries. For example, in trench 2 (pl. 40, geologic section *A–B*) individual deposits extend across lithologic boundaries between shale, sandy claystone, sandstone, clayey siltstone, sandy siltstone, and pebbly sandstone. In trench 10 (pl. 41, geologic section *J′–K′*) a lenticular deposit extends northward across sandy siltstone and clayey siltstone of the Eocene rocks, then across sand and silt of Quaternary age, and finally back into pebbly sandstone of Eocene age.

Deposits limited essentially to individual beds are less common than the deposits that extend across the bedding planes. In trench 2 (pl. 40) one deposit in section *A–B* is limited mainly to a shale bed that overlies sandstone, and another deposit in geologic section *B–C* is in a claystone bed overlying pebbly sandstone.

The detailed mapping in the trenches indicated that the schroeckingerite mineralization is not limited to any single lithologic type or color of host rock but that the richest concentrations seem to occur in green and gray-green fine-grained rocks. For example, deposits in trench 3 (pl. 40) occur in shale of the Tipton tongue, in the wide range of sedimentary sizes from claystone to pebbly sandstone in the undifferentiated intertonguing Battle Spring formation and Cathedral Bluffs tongue, and even in the sands and silts of the Quaternary overburden. Although this diversity of host rock is pronounced, the richest portions of deposits in trench 3 and the other trenches occur in beds of green and gray-green siltstone, clayey or sandy siltstone, and sandy or silty claystone.

Although the area of known schroeckingerite mineralization is located areally along the trend of the Cyclone Rim fault zone near its junction with northeasterly faults, in detail the individual schroeckingerite deposits are not limited completely to the immediate vicinity of faults. Thus, for example, the northern part of the mineralized area (pl. 37) extends beyond the limits of the most complex faulting of the Cyclone Rim zone. Within the fault zone, some of the faults in the trenches are directly associated with schroeckingerite deposits, whereas other faults are barren of deposits. In trench 3 (pl. 40) the schroeckingerite deposits at the north end of geologic section *D–E* are directly adjacent to southward-dipping normal faults, but some of the other faults in the same section are not associated with deposits. Some of the deposits extend across fault planes. For example, in trench 1 (pl. 39) deposits in the immediate vicinity of a southward-dipping normal fault are limited to the hanging-wall side on the southeast wall of the widened part of the trench (geologic section *X′–Y′*); but northwestward along the strike of the fault (progressively through geologic sections *B′–C′*, *B–C*, *X–Y*), the deposits extend across the fault, and on the northwest wall of the widened part of the trench (geologic section *X–Y*) are limited largely to the footwall side. Other deposits observed in the trenches have no apparent detailed relationship to any exposed faults.

GRADE

Schroeckingerite forms less than 1 percent of the rock within the boundaries of individual schroeckingerite deposits in the Lost Creek area. The detailed distribution of schroeckingerite in the mineralized rock is so irregular that the boundaries of individual deposits in the trenches were mapped according to the presence or absence of schroeckingerite. The uranium content of samples from schroeckingerite deposits in the trenches that were excavated under the direction of the U.S. Geological Survey ranges from 0.001 to 0.260 percent; most of the samples contain less than 0.050 percent uranium. The highest uranium content of any of the samples obtained from drill holes during the exploration is 0.063 percent.

The uranium content of trench samples from host rock containing no schroeckingerite ranges from 0.000 to 0.039 percent; most of these samples contain less than 0.005 percent uranium.

The locations and analyses of representative samples from the trenches are indicated on plates 39 to 41.

MINERALOGY

Schroeckingerite was described by Schrauf (1873, p. 137–138), who named it after J. von Schröckinger. Von Schröckinger subsequently (1875, p. 66–68) described the occurrence of schroeckingerite in the type locality at Joachimsthal, Bohemia (now Nový Jáchymov, Czechoslovakia). At Joachimsthal the schroeckingerite is an alteration product of uraninite.

Schroeckingerite from the Lost Creek locality in Wyoming has had an interesting descriptive history. An unidentified yellow mineral had long been noted in the Lost Creek area by Mrs. Minnie McCormick (now deceased) of Wamsutter, Wyo. The exact date of her discovery is not known, but it was made before 1936. Mrs. McCormick's interest in learning the identity of the mineral led eventually to its description by Larsen (1937, p. 7), and Larsen and Gonyer (1937, p. 561–563) as "dakeite," a new secondary uranium mineral named in honor of H. C. Dake. The "dakeite" from Wyoming was also described by Knight and Gilbert (p. 395) and by Dake (1938, p. 7–8, 23–25). The mineral "dakeite" later was proved by Nováček (1939, p. 317–323) to be identical with schroeckingerite, and the name "dakeite" is no longer accepted.

Schroeckingerite is a micaceous, orthorhombic mineral with perfect basal cleavage. Its hardness is 2.5 and specific gravity is 2.51. The color in daylight ranges from greenish-yellow to yellow. One of the outstanding physical characteristics of schroeckingerite is its brilliant yellow-green fluorescence in ultraviolet light. The optical properties of schroeckingerite have been described by Larsen and Gonyer (1937, p. 562, for "dakeite"), by Nováček (1939, p. 319) and by Jaffe, Sherwood, and Peterson (1948, p. 156).

Chemically, schroeckingerite is a hydrated fluo-carbonate-sulfate of sodium, calcium, and uranium—$NaCa_3(UO_2)(CO_3)_3(SO_4)F \cdot 10H_2O$

(Palache, Berman, and Frondel, 1951, p. 236). A chemical analysis of schroeckingerite from the Lost Creek locality by Sherwood (*in* Jaffe and others, 1948, table 2) is as follows:

	Percent		Percen
CaO	18.14	R_2O_3	0.95
Na_2O	3.63	SiO_2	.08
UO_3	31.44		
CO_2	14.20		99.91
SO_3	9.17	Deduct O=2F	.90
F	2.15		
H_2O	20.15		99.01

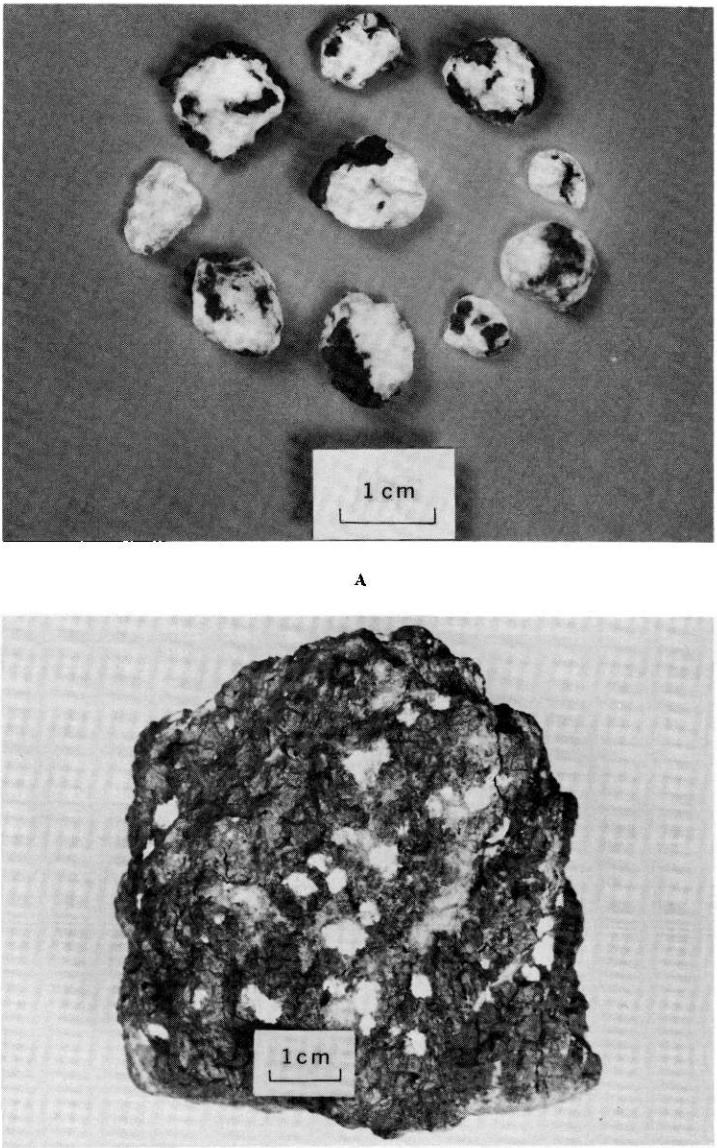
Earlier analyses by Schrauf (1873, p. 137–138), Larsen and Gonyer (1937, p. 562, for "dakeite"), and Nováček (1939, p. 319) did not report the presence of fluorine in the mineral.

Schroeckingerite contains about 27 percent uranium. Despite its high uranium content the mineral is only weakly radioactive. Radiometric and chemical analyses were made by the U.S. Geological Survey on a hand-picked concentrate of schroeckingerite from the Lost Creek locality. It was estimated that the concentrate contained only about 1 percent impurities. The results showed 11.0 percent equivalent uranium and 24.5 percent uranium. The lower equivalent-uranium content indicates a disequilibrium relation in which the mineral has a relative deficiency in radium. Much of the schroeckingerite has formed so recently that uranium and its disintergration products have not attained radioactive equilibrium. This relationship between equivalent uranium and uranium is shown graphically (pl. 42) for the samples from schroeckingerite deposits in trenches excavated under the direction of the U.S. Geological Survey.

In the Lost Creek area schroeckingerite occurs as rounded to ellipsoidal pellets; as very small flaky crystals coating sand grains; as small tabular masses along bedding planes in shale and along shrinkage cracks, and with silica, carbonate, and (or) gypsum in encrustations and small veinlets. It is also found as minute grains in the white efflorescent salts of surface encrustations.

The concretionary (pellet) form, in which schroeckingerite occurs as clusters or aggregates of scales, is most common in the Lost Creek area. Typical pellets and typical pellet-bearing rocks are illustrated in figures 31 and 32. Individual pellets range in diameter from about 0.01 inch to 1.5 inches; the most common size is 0.2 inch. Commonly the pellets contain tiny crystals of gypsum interleaved with the scales of schroeckingerite.

Schroeckingerite is commonly associated with white to flesh-colored fine-grained gypsum; less commonly, it is associated with opal and carbonate materials. The fine-grained gypsum occurs as irregular

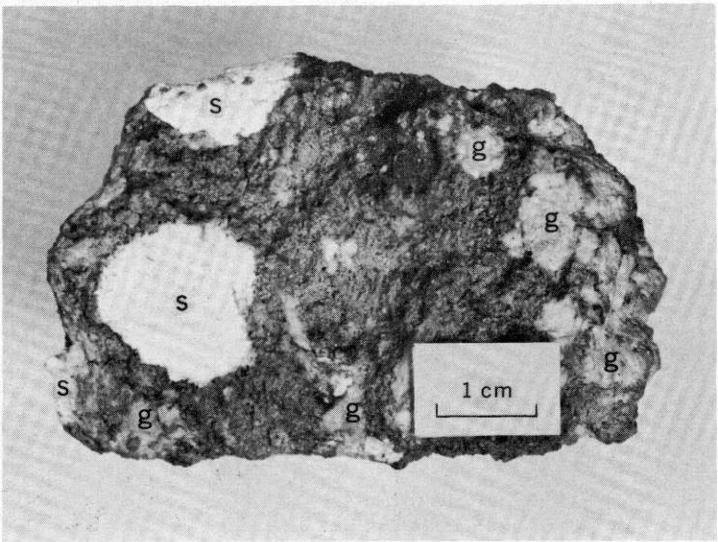


A

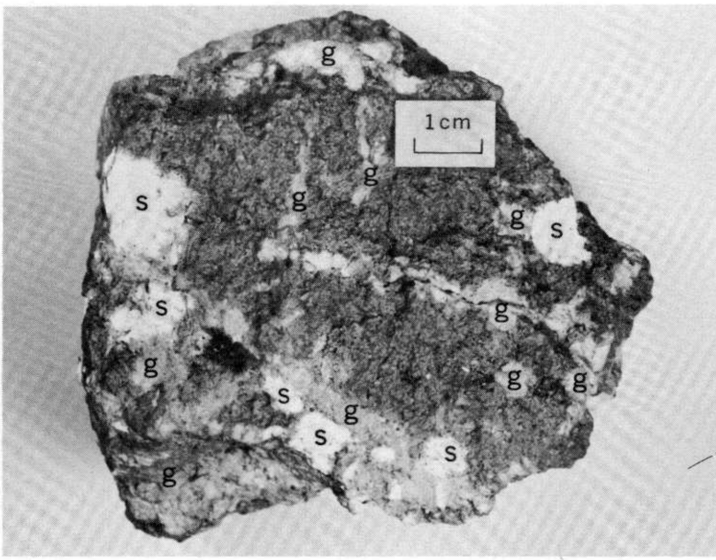
B

FIGURE 31.—Typical schroeckingerite of the Lost Creek deposits, Sweetwater County, Wyo. *A*. Schroeckingerite pellets in dark-colored clay and silt. *B*. Pellet-bearing rock; the rock is green sandy siltstone; the light-colored spots are mostly schroeckingerite, with minor amounts of gypsum.

masses (fig. 32*A*), and as disseminations and veinlets (fig. 32*B*) in the host rock. No base metals were observed in the schroeckingerite deposits, although pyrite, presumably of sedimentary origin, was found



A



B

FIGURE 32.—Schroeckingerite associated with gypsum in brown-gray silty sandstone. *A*, Large schroeckingerite pellets (*s*) at left and irregular masses of gypsum (*g*) at right. *B*, Schroeckingerite pellets (*s*) and gypsum (*g*) in veinlets and irregular masses.

in the same general area; the pyrite occurs as a few concretionary masses in siltstone in the Cathederal Bluffs tongue.

The gypsum and the pellets of schroeckingerite probably form by displacement of the materials of the host rock. No detailed petrographic studies of the schroeckingerite-bearing rocks were made, because the mineral is so friable and soluble that it is extremely difficult to retain original textures in a thin-section.

Additional data on the mineralogy of rocks from the Lost Creek area have been included in a report by Wyant, Sharp, and Sheridan (1956, p. 260–263, 269–270).

SOLUTION AND REDEPOSITION

Observation of natural occurrences and laboratory syntheses demonstrate that schroeckingerite is dissolved and redeposited by natural surface and ground waters. Wyant and others (1956, p. 261) reported that individual crystals and pellets of schroeckingerite, that were exposed in dumps of exploratory trenches, dissolved during the winter season, and, in the dry season, reprecipitated as thin efflorescent coatings. Similar examples of solution and redeposition as efflorescent coatings have been observed along the cutbank of Lost Creek east of the cabin (pl. 38). The authors of the present report observed very fine crystals having the typical fluorescent color of schroeckingerite in the yellow-white efflorescent crust that formed along the water line in the south end of the northern half of trench 8 and in the north end of trench 7. This efflorescent material crystallized from the water in the trenches.

G. B. Guillotte (written communication, 1945) performed an experiment that illustrated that schroeckingerite pellets can form in a short time. He pulverized schroeckingerite pellets in shale and mixed a slurry of this material with water until all the schroeckingerite had dissolved. After the mud had dried, he found that it contained schroeckingerite pellets similar to those that were in the original rock specimens.

An interesting series of experiments were also performed recently by Wayne Mountjoy using a sample of pulverized schroeckingerite-bearing rock (0.092 percent uranium) and water with components adjusted to conform to those of Lost Creek water. These tests were performed as part of research with Harold Masursky on enrichment of coal by uranium from aqueous solutions. Mountjoy and Masursky (oral communications, March 1955) found that 83 percent of the uranium in the rock sample was leached by successive leachings with 7 one-liter portions of the unheated water.

ORIGIN

DEPOSITION OF THE SCHROECKINGERITE

The schroeckingerite deposits in the Lost Creek area are epigenetic in character, and deposition of the mineral is continuing at the present time. The deposits are believed to form by a simple process of crystallization from uraniferous waters, a process thought to be similar to that by which caliche deposits of calcium carbonate, borax, and other similar materials are formed at or near the surface in other arid and semiarid regions of the world. In the Lost Creek area the immediate source of the uranium in the schroeckingerite is the uraniferous ground water. The schroeckingerite apparently forms by evaporation of capillary water in the zone between the water level and the surface of the ground in those parts of the area where the ground water is relatively near the surface. In those parts of the area where the ground water level is now considerably below the deposits, upward fluctuation of the water level in Pleistocene or Recent geologic time probably accounted for the deposits. Downward-percolating surface waters also contribute to the process by a certain amount of solution and redeposition of the schroeckingerite.

The exact time in geologic history when deposition of the schroeckingerite in the Lost Creek area started is not known. The present distribution suggests that it started after the folding and erosion of Eocene rocks. Possibly deposition of schroeckingerite started about the same time that faulting occurred in the area or slightly thereafter—that is, in Miocene or post-Miocene time. The fact that the mineral is easily dissolved and redeposited, however, prohibits exact dating of the initial deposition.

The evidence for the caliche type of deposition lies mainly in the present distribution of the schroeckingerite deposits. The known deposits are all within 14 feet of the present ground surface, and most of them occur at depths ranging from 2 to 8 feet. There may be deeper deposits of schroeckingerite, but existing data suggest that the ground-water level is the lower limit of deposition. Within this near-surface zone the deposits commonly extend across lithologic boundaries and faults in the northward-dipping Eocene strata and lie subparallel to the surface. Some of the deposits are in the surficial Quaternary material and some overlap the unconformity at the base of the Quaternary deposits. This pattern of distribution is consistent with a simple epigenetic process of formation by evaporation.

The fact that most of the richest deposits occur in siltstone or silty claystone indicates the manner of deposition and explains the tendency for deposits to be elongate parallel to the strike of the bedding. The physical nature of silty sedimentary rocks makes them more susceptible to capillary action than coarser sedimentary rocks or highly indurated finer sedimentary rocks like shale. Water is probably drawn into and retained longer by the silty beds, thereby allowing slow crystallization and the accumulation of abundant concretionary pellets of schroeckingerite along the strike of the favorable beds. Portions of deposits that lie in sandstone beds, however, are generally of lower grade and the schroeckingerite tends to coat the grains rather than to form large discrete pellets.

The uranium content of schroeckingerite is higher than the equivalent uranium percentage, as shown in the graph of analytical results from trench samples (pl. 42). This disequilibrium relation is explained by the fact that the schroeckingerite deposits are continually changing by processes of solution and redeposition. Apparently none of the schroeckingerite remains unaffected long enough for the disintegration products of uranium to reach radioactive equilibrium with the uranium. Most of the uranium that goes into solution probably is redeposited essentially within the limits of the mineralized area, because no uranium deposits have been found downstream along the Lost Creek drainage.

SOURCE OF THE URANIUM

Although the ground water is believed to be the immediate source of the uranium in the schroeckingerite deposits, the source from which the ground water obtained the uranium has not been established by direct evidence. Presently available geologic data are entirely from the near-surface part of the Lost Creek area and are sufficient only to provide indirect evidence for the source of the uranium.

PREFERRED HYPOTHESIS

The authors believe that the Lost Creek area contains unexposed deposits of uranium minerals from which ground water obtains uranium and deposits it near the surface as schroeckingerite. These hypothetical source deposits are believed to be relatively high in grade compared to the schroeckingerite deposits and may contain pitchblende, uraninite, or other so-called primary uranium minerals. The source deposits may be located at depth in the general area of the schroeckingerite deposits or they may be located laterally from the area of schroeckingerite deposition along or near one or more of the faults in the area.

Indirect evidence in favor of the high-grade source deposits in the Lost Creek area is the relatively restricted area of occurrence of the schroeckingerite. If low-grade rocks had been the source, they necessarily would have a wide areal extent in order to supply the total uranium for the large accumulation of schroeckingerite. Such low-grade rocks are abundant and widespread in the Tertiary section throughout the Great Divide Basin, but schroeckingerite deposits have not been found elsewhere in the basin in geologic settings similar to those at Lost Creek. It does not seem likely that leaching of widespread rocks of low uranium content could produce schroeckingerite in one area but not in other areas having the same geologic conditions.

The coexistence of schroeckingerite and faults in the Lost Creek area is a geologic condition favorable to the presence of the hypothetical source deposits, because many uranium deposits in other areas are related to structural controls. It is true that individual schroeckingerite deposits do not seem to be restricted to individual faults in the Lost Creek area, but present distribution of the deposits is partly the result of continuing solution and redeposition, so that individual deposits extend across many lithologic and structural planes. More important than the detailed distribution, however, is the close areal relationship of the area of schroeckingerite mineralization to the Cyclone Rim zone of faulting and to the other faults in the Lost Creek area; this areal relationship suggests that fault structures may have played a part in the genesis of the deposits. The proximity of the area of schroeckingerite mineralization to the intersection of northwesterly and northeasterly faults (pls. 36 and 37) is similar to the locations of mineral deposits in many classic localities. Also, the probability that the Lost Creek fault system is part of a very long regional fault system suggests additional similarities to many other classic types of mineral deposits along similar major structural features.

Abnormal stream and ground-water conditions in the Lost Creek area are probably related closely to the fault pattern and to the schroeckingerite deposition. Lost Creek, intermittent over most of its course, is permanently flowing for about 3 miles only in the vicinity of the schroeckingerite deposits. Drilling data obtained in and near the mineralized area also indicate the presence of water-saturated layers, possibly perched water tables, above the true water table. It is probable that ground-water movements in the vicinity of the schroeckingerite deposits are controlled partly by faults and that abnormalities in water levels are caused by ground water rising along faults and along favorable faulted stratigraphic horizons. The coexistence of faults, schroeckingerite deposits, and abnormal stream and water conditions in the Lost Creek area is favorable to the hypothesis that uranium was derived from concealed sources located along or near one or more of the faults in the area.

In many uranium districts in the western United States schroeckingerite is one of a group of secondary uranium minerals that is often a "guide" to ore. In fact, every other occurrence of schroeckingerite known to the authors is either related directly to a deposit of other uranium minerals or the genetic relations can be inferred by the presence of other uranium deposits in the same general area of occurrence. The available data on occurrences of schroeckingerite is summarized in the following table. There is no necessity for the Lost Creek deposits to conform genetically to any of the other occurrences, but the authors believe that the geologic relations at the other occurrences merit careful consideration. The evidence from the other localities favor a relatively high-grade source of uranium.

Certain similarities exist between the geologic setting at Lost Creek and the geology of other uranium deposits in Wyoming. Many deposits are in Tertiary sedimentary rocks and in areas characterized by faults, although the work in many of these areas is so new that the detailed genetic history cannot be evaluated yet. The Crooks Gap uranium area in Fremont County, about 20 miles northeast of the Lost Creek area, contains a prominent northwestward-trending fault zone, that is shown in the vicinity of Crooks Mountain and Green Mountain on the Geologic Map of Wyoming (Love and others, 1955). J. G. Stephens (written and oral communications, 1954 and 1955) has noted that uranophane is the principal uranium mineral in deposits in arkosic sandstone in the lower part of the Wasatch formation in the Crooks Gap district. He notes that uraninite and coffinite also have been identified in these deposits. Grutt (1955, p. 107) reports that autunite occurs as the principal uranium mineral near a large thrust fault in the northern part of the Crooks Gap area and that considerable faulting is evident in the area of uranophane deposits south of the thrust fault. M. H. Bergendahl (oral communication, 1955) observed schroeckingerite along the underside of a thrust fault in the Green Mountain area near Crooks Gap. Farther north in Fremont County is the Gas Hills uranium district, where faults of Pliocene(?) or more recent age occur in the same area as uranium deposits in the Wind River formation of Eocene age (H. D. Zeller, oral communication, 1955). Vine and Prichard (1954) have described uranium occurrences near Baggs in the Poison Basin area of southern Wyoming. They found schroeckingerite and uranophane in deposits in the Browns Park formation of probable Miocene age. Grutt (1955, p. 108) noted that preliminary drilling in the Baggs area has suggested that some of the uranium has been localized along fractures or fault trends as well as along the bedding. It is interesting to note that Bradley (1945) has illustrated an eastward-trending fault zone that extends across the southern part of the Washakie Basin in the vicinity of Baggs.

Known occurrences of schroeckingerite

Location	Other uranium minerals	Occurrence and geologic relations	References	Remarks
1. Lost Creek area, Sweetwater County, Wyo.	None identified	Rounded to ellipsoidal pellets; also flakes and coatings. In caliche-type, near-surface deposits in Eocene rocks (Cathedral Bluffs tongue of Wasatch formation and Tipton tongue of Green River formation) and in Quaternary overburden. Deposits are in and near the Cyclone Rim zone of faulting.	The present report (see also references cited in chapter on schroeckingerite deposits).	Largest known group of schroeckingerite deposits in the world. Immediate source of uranium is uraniferous ground water. Authors of present report believe that uranium is coming from unexposed uranium deposits of relatively high grade; these hypothetical source deposits are believed to be in the Lost Creek area.
2. Joachimsthal, Bohemia (now Nový Jáchymov, Czechoslovakia).	Uraninite	Globular and flaky groups on uraninite. Dana's system of mineralogy (Palache, Berman, and Frondel, 1944, no. 1, p. 614) lists Joachimsthal under hydrothermal Co-Ni-Bi-Ag-As veins, and lists the oxide occurrences there as pitchblende.	Descriptions: v. Schröckinger (1875, p. 66–68; Schrauf (1873, p. 173–178); Nováček (1939, p. 317–323).	Type locality.
3. Marysvale area, Piute County, Utah.	Uranophane, autunite, torbernite, pitchblende.	In a group of secondary uranium minerals in weathered and hydrothermally altered Tertiary igneous rocks, along faults that contain hydrothermal vein deposits of pitchblende, quartz, fluorite, pyrite, and sulfides at depth.	D. G. Wyant, F. Stugard, Jr., and E. P. Kaiser (written communication, 1950); H. C. Granger and H. L. Bauer, Jr. (written communication, 1950); Stugard, Wyant, and Gude (1952).	
4. Hillside mine, Yavapai County, Ariz.	With andersonite, swartzite, and bayleyite.	As coating ⅛ in. thick on gypsum on mine walls on 300-foot level; located in oxidized zone 40 feet above water level. Mine openings are in Cretaceous or early Tertiary vein cutting Precambrian rocks. Vein contains pyrite, arsenopyrite, galena, sphalerite, tetrahedrite, and copper sulfides.	Axelrod, Grimaldi, Milton, and Murata (1951, p. 1–22).	Found on the 300-ft level. Pitchblende and johannite occur on the 400-ft level. Axelrod and others (1951, p. 2) state that source of uranium is unknown but may be in the vein or in small aplite-pegmatite dikes.
5. Cochetopa Creek district, northwestern Saguache County, Colo.	Autunite	In hydrothermally altered zone along a fault cutting Precambrian rocks and the Morrison formation (Jurassic). Pitchblende at depth, in hydrothermal deposits, Tertiary in age.	Thornburg (1955)	Presumably the schroeckingerite and other secondary uranium minerals were derived from the pitchblende deposits, which were cut by a drill hole along the fault.

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6. Black Cloud mine, Gold Hill district, Boulder County, Colo.	Pitchblende (?)	As pellets on mud-coating on mine walls. Mine is in Tertiary vein cutting Precambrian rocks. Vein contains gold, silver, galena, sphalerite, and dark claylike material, which may be pitchblende, filling fissures in vein. (R. U. King, written com-communication, 1956.)	Schroeckingerite observed by R. H. Campbell (oral communication, 1955). Mine description (R. U. King, written communication, 1956).	Presumably the source of the uranium may be pitchblende in hydrothermal vein.
7. Shinarump No. 1 Uranium mine, Seven Mile Canyon area, Grand County, Utah.	Becquerelite, uraninite	With becquerelite along fractures and bedding planes near edges of uraninite deposit nearest the surface. Mine is in basal siltstone of Chinle formation (Triassic).	Finch (1954)	The schroekingerite and becquerelite presumably are secondary alteration products derived from the uraninite deposit. Finch (1954, p. 13) states that the most abundant ore mineral is uraninite and believes the origin of the uranium deposit to be hydrothermal.
8. Shinarump No. 3 mine, Seven Mile Canyon area, Grand County, Utah.	Uraninite, tyuyamunite, carnotite.	With other uranium minerals and with copper minerals at contact of Moenkopi and Chinle formations (Triassic). Hurlbut (1954, p. 902) states that the schroeckingerite occurs with gypsum in seams in shale.	Gruner and Gardiner (1952, pl. 22–23). Hurlbut (1954, p. 901–907).	Presumably the schroeckingerite is a secondary alteration product derived from copper-uranium deposit.
9. Hideout No. 1 (Tiger) mine on Deer Flats, north side of White Canyon, San Juan County, Utah.	Bayleyite, pitchblende or uraninite.	With bayleyite in yellow efflorescent crust in adit less than 100 feet from cliff face. Mine is in a copper-uranium deposit in the Shinarump member of the Chinle formation (Triassic).	Stern and Weeks (1952); Benson, Trites, Beroni, and Feeger (1952). A. F. Trites, Jr., and T. L. Finnell (written communication, 1953).	Presumably the schroeckingerite and bayleyite were derived from the copper-uranium deposit. Benson and others (1952, p. 8) favor the hypothesis that the copper-uranium ores of White Canyon area were brought to their present locations by hydrothermal solutions in early Tertiary time.
10. Cane Creek anticline, Moab district, San Juan County, Utah.	Andersonite, bayleyite, carnotite, metatyuyamunite, betazippeite.	With other uranium minerals and copper minerals in deposits in the Chinle formation (Triassic) that are localized along faults on the Cane Creek anticline.	E. N. Hinrichs (oral communication, 1955).	
11. Colorado No. 1 mine, Moab district, San Juan County, Utah.	Uraninite	As coatings on fractures in uraninite deposits in Moss Back member of Chinle formation (Triassic). The schroeckingerite is an alteration product of uraninite.	E. N. Hinrichs (oral communication, 1955).	

Known occurrences of schroeckingerite—Continued

Location	Other uranium minerals	Occurrence and geologic relations	References	Remarks
12. Crabapple claim, Green River district, Utah.	Pitchblende	As an alteration product of pitchblende in deposit in Chinle formation (Triassic).	Schroeckingerite occurrence: Weeks and Thompson (1954, p. 35). Geologic data: W. I. Finch (oral communication, 1955).	According to W. I. Finch (oral communication, 1955) the deposit is the Colorado Plateau type, contains uranium and minor copper and vanadium, is localized in an ancient stream channel, and is associated with carbonaceous material.
13. McCoy-Flattop area, Thompsons district, 15 miles southeast of Thompsons, Grand County, Utah.	Carnotite	In a near-surface deposit in mudstone. Carnotite is the principal uranium mineral in nearby deposits in the Thompsons district.	Cannon (1952, p. 748, 751)—botanical studies.	Presumably the schroeckingerite is a secondary alteration product derived from nearby carnotite deposits.
14. Parco No. 25 mine, Yellow Cat group, Thompsons district, Grand County, Utah.		Listed by Weeks and Thompson (1954, p. 36) but no geologic relations given.	Weeks and Thompson (1954, p. 36).	Presumably the schroeckingerite is a secondary mineral derived from nearby carnotite deposits of the Colorado Plateau type.
15. Trader Smith's claims, 15 miles west of Cisco, Grand County, Utah.		Listed by Gruner and Gardiner (1952, p. 21); no geologic relations given.	Gruner and Gardiner (1952, p. 21).	Presumably the schroeckingerite is a secondary mineral derived from uranium deposits of the Colorado Plateau type.
16. Sevastopol claims, Butler Wash, 15 miles south of Blanding, San Juan County, Utah.		do	do	Do.
17. Poison Basin area, Carbon County, Wyo.	Uranophane	As the principal uranium mineral in one sample; uranophane is the principal uranium mineral in 3 selected samples. All occurrences are in the Browns Park formation of probable Miocene age.	Vine and Prichard (1954).	
18. Green Mountain area, Fremont County, Wyo.		In the Cody shale (Upper Cretaceous) along the underside of a thrust fault.	M. H. Bergendahl (oral communication, 1955).	

The similarities in geologic setting suggest that hypothetical source deposits in the Lost Creek area may duplicate the mineralogy and character of one or the other of the uranium districts in Wyoming. Thus, the source of the uranium may very well be unexposed deposits containing uranophane and uraninite, similar to those in the nearby Crooks Gap area. In the Lost Creek area the occurrence of schroeckingerite and the environment of faulted Tertiary sedimentary rocks may be geologic criteria favorable to the presence of unexposed high-grade source deposits.

OTHER HYPOTHESES

Other hypotheses that might explain the source of the uranium in the Lost Creek schroeckingerite deposits are concerned either with derivation of the uranium from uraniferous coal, from other source materials of low grade, or from lake or stream waters.

As a result of an earlier examination of the Lost Creek area, Wyant, Sharp, and Sheridan (1956, p. 272) arrived at the same conclusion for the manner of schroeckingerite deposition as did the authors of the present report—namely, crystallization from ground-water or surface-water solutions. Data obtained from the earlier fieldwork (Wyant and others, 1956, p. 273–274), however, suggested that the uranium was derived from buried uraniferous lignite (now called subbituminous coal). New research data have appeared since the time the earlier fieldwork was done. I. A. Breger and M. Deul (written communication, 1952) have reported that uranium occurs in uraniferous lignite from South Dakota as an organouranium compound or complex, soluble at a pH of less than 2.18. I. A. Breger, M. Deul, R. Meyrowitz, and S. Rubinstein (written communication, 1953) have found that uranium in subbituminous coal from the Red Desert is also associated with the organic constituents of the coal. If it can be assumed that the Red Desert uraniferous coal is similar to the South Dakota lignite with respect to solubility of uranium, then leaching of uranium from Red Desert coal would be possible only under highly acidic conditions. Such highly acidic conditions do not appear likely in the subsurface area at Lost Creek because most of the ground water today has a pH of about 8.

The newer research data show that it is less likely than was previously supposed that uraniferous coal in the subsurface area beneath the schroeckingerite deposits is the source of the uranium.

Another group of hypotheses explains the origin of the uranium by leaching from widespread sedimentary rocks or volcanic rocks of low uranium content. A. L. Slaughter and J. M. Nelson (written communication, 1946) noted that moderately radioactive clay and shale are widespread in the Red Desert and suggested that these radioactive sedimentary rocks are the direct source of the uranium in the schroeckingerite. Bell (1954, p. 112) cited the schroeckingerite occurrences of the Red Desert as an example of uraniferous caliche-type deposits that are formed in semiarid regions where small amounts of ground and surface waters leach the soluble uranium compounds from slightly uraniferous formations exposed at the surface or lying at shallower depths. The idea of a widespread source, of course, could be applied equally well to the Eocene rocks in which most of the schroeckingerite occurs, to slightly older Tertiary rocks underlying the area, or to younger Tertiary or Quaternary strata that now overlie, or that once were overlying, the present host rocks of the schroeckingerite. Other authors have postulated that widespread overlying rocks were the source of the uranium in coal and other deposits. N. M. Denson and others (written communication, 1952) proposed an epigenetic hypothesis to explain the origin of uranium in coal and lignite of Rocky Mountains region. They believe that leaching of overlying rocks of volcanic origin adds uranium to the ground water and that the uranium may be deposited immediately below the overlying rocks or may be moved considerable distances before being deposited "by adsorption on phosphatic, carbonaceous, or clayey beds." Love (1952, p. 17) also applied this same hypothesis to uranium deposits that occur in sedimentary rocks of the Wasatch formation in the Pumpkin Buttes area of Wyoming. H. Masursky and G. N. Pipiringos (written communication, 1953) concluded that downward and lateral movement of uranium from a widespread overlying source is indicated in the Red Desert by the widespread relation of coal of relatively high uranium content with permeable zones and with topographic and stratigraphic highs. H. Masursky, G. N. Pipiringos, and H. D. Gower (written communication, 1953) pictured the source as sandstone and conglomerate of Miocene age, from which downward-percolating waters carried the uranium to "receptor" coal beds. Pipiringos (1956, p. 438) concluded that the most probable source of uranium in coal beds and the schroeckingerite deposits in the central part of the Great Divide Basin is the tuffaceous sandstone of the Browns Park formation (Miocene?).

The general ideas expressed by Slaughter and Nelson, Bell, Denson, Love, and others are inadequate if they are applied to the Lost Creek schroeckingerite deposits because their hypotheses do not explain the fact that schroeckingerite is localized in a relatively small part of the Red Desert and the Great Divide Basin. It is certainly true, for example, that tuffaceous rocks are abundant and widespread. Examples are the Miocene tuffaceous sandstone and tuffaceous beds in the Bridger formation north of the Lost Creek schroeckingerite area. Also, bentonitic beds of volcanic origin occur in the rocks of the Green River formation and some are located within the area of schroeckingerite mineralization. If such rocks were the source of the uranium in the schroeckingerite, it is very difficult to explain the absence of schroeckingerite elsewhere in the Great Divide Basin where essentially the same geologic conditions exist. Therefore, leaching of widespread low-grade rocks is not a satisfactory explanation of the schroeckingerite.

Another group of hypotheses are concerned with deposition of the schroeckingerite from lake or stream waters. Dake (1938, p. 23) stated that it was possible that the "dakeite" (schroeckingerite) was brought in by waters of a lake or stream flowing into the lake, possibly from an origin in granite hills in the distance. Wyant, Sharp, and Sheridan (1956, p. 274) noted, as one of several hypotheses, that uranium derived from surrounding basement rocks may have accumulated in Eocene Green River lakes and that the schroeckingerite may have precipitated in the near-shore mud when the lake evaporated. The same idea could apply also to younger lakes or streams. E. P. Beroni and F. A. McKeown (written communication, 1952) noted that arkosic sedimentary rocks of Miocene(?) age in the vicinity of Green Mountain, 20 miles north of the schroeckingerite deposits, are appreciably radioactive and that it is possible that the radioactive material in the soil and lignite south of the area may have been derived from these sedimentary rocks.

None of these hypotheses dealing with lake or stream deposition explains the localization of the schroeckingerite deposits in a relatively restricted area in the Great Divide Basin. Wyant, Sharp, and Sheridan (1956, p. 274) raised similar objections to this type of hypothesis. If, for example, the headwaters of Lost Creek obtained uranium from uranium deposits or uraniferous sediments in the vicinity of Crooks Gap near Green Mountain, 20 miles northeast of the schroeckingerite deposits, then uranium minerals including schroeckingerite probably should be found elsewhere along the Lost Creek drainage. The fact that there are no uranium minerals elsewhere along the drainage and the schroeckingerite deposits are all east of Lost Creek, rather than extending along the creek, are evidences against the source having been in the distant uranium deposits at Crooks Gap. If deposition in the near-shore parts of Eocene lakes is assumed, it is extremely difficult to explain the lack of schroeckingerite in many other exposures of near-shore Eocene beds. Even if the schroeckingerite had been precipitated as a near-shore feature of a

Green River lake in this one locality alone, it is very difficult to understand how there would be any remaining evidence. If lakes during Pleistocene time are assumed to have been the sites of deposition, then many other occurrences should have been found in the Great Divide Basin.

CONCLUSIONS

The most likely source of the uranium in the schroeckingerite is in relatively high-grade concealed uranium deposits located in the Lost Creek area. These hypothetical source deposits may be of hydrothermal origin, either directly or indirectly, or they may be structurally and (or) stratigraphically controlled deposits of uncertain origin.

RESERVES

The schroeckingerite deposits of the Lost Creek area constitute a large reserve of uraniferous material, but the majority of samples contain less than 0.050 percent uranium. The deposits are distributed irregularly near the surface in an area totalling about 13,000 feet in length and 3,000 feet in maximum width (pl. 37). The main zone containing schroeckingerite deposits is 6 feet thick and the average thickness of individual deposits is 1.5 feet. Individual deposits as much as 80 feet wide and 390 feet long contain a few irregular areas barren of schroeckingerite.

The low grade of the deposits has been detrimental to commercial development, but the high solubility of schroeckingerite is a factor favorable to the potential economic use of the deposits. The fact that schroeckingerite is soluble in the waters at Lost Creek suggests that it might be possible to produce a shippable concentrate by large-scale methods, involving leaching and natural evaporation.

In addition to the schroeckingerite deposits, the Lost Creek area may contain unexposed uranium deposits of relatively high grade. Data pertaining to these hypothetical deposits are included in the discussion on source of the uranium and in the suggestions for prospecting.

OTHER RADIOACTIVE MATERIALS

TYPES

Radioactive materials other than schroeckingerite are also present in some of the samples of sedimentary rocks taken from the near-surface portion of the Lost Creek area. These materials seem to be of two general types: material having a higher percentage of uranium than equivalent uranium and material having a lower percentage of uranium than equivalent uranium. No uranium minerals have been identified in any of the samples containing these materials, and the highest uranium content in samples of these types is only 0.039 percent. If the uranium occurs in these materials in mineral form, it must be such a poorly crystallized mineral that it cannot be separated or identified by ordinary means. It is also possible that the uranium may be adsorbed on clay or that there may be uncombined uranium ions in the interstitial water.

The radioactive materials other than schroeckingerite occur in poorly defined deposits, the boundaries of which could not be determined readily by field methods. The presence of such materials was indicated by the anomalous amounts of uranium found in numerous rock samples containing no schroeckingerite.

Many samples of sedimentary rocks obtained from trenches and drill holes in the area known to contain schroeckingerite deposits contain abnormal amounts of uranium but no schroeckingerite. In most of these samples, the percentage of uranium is higher than the percentage of equivalent uranium. Some of the samples were taken very close to known schroeckingerite deposits but contain no schroeckingerite. For example, in trench 5 a horizontal channel sample was taken in clayey siltstone of the Cathedral Bluffs tongue, three-fourths of a foot above a schroeckingerite deposit; the sample contains 0.016 percent equivalent uranium and 0.029 percent uranium. Similar anomalous amounts of uranium were found in channel samples above some of the schroeckingerite deposits in trench 7. This type of uraniferous material is not restricted to the area above schroeckingerite deposits. For example, in trench 3 (pl. 40, geologic section *D′–E′*) a sample was taken in brown shale of the Tipton tongue, 3 feet below a schroeckingerite deposit; it contains 0.009 percent equivalent uranium and 0.024 percent uranium. Other examples of this type of uraniferous material occur in the general vicinity of schroeckingerite deposits but not directly above or below such deposits. In trench 8, a sample in clayey siltstone contains 0.006 percent equivalent uranium and 0.011 percent uranium, and was taken 15 feet from the nearest exposure of schroeckingerite. Claystone at 12–14 feet in a drill hole near trench 1 contains 0.015 percent equivalent uranium and 0.023 percent uranium; no schroeckingerite was cut by the drill hole.

Less common in the general area of schroeckingerite deposits is radioactive material having higher equivalent uranium than uranium, but no schroeckingerite. In Trench 5, a sample in sandy siltstone of the Cathedral Bluffs tongue contains 0.016 percent equivalent uranium but only 0.009 percent uranium. Some iron-stained zones along the contacts between adjacent beds are slightly radioactive but the uranium content is very low.

The site for trench 13 (pl. 37) was selected on the basis of an anomaly logged from an airplane and reported to occur in the general area

(H. Masursky and N. M. Denson, oral communications, 1952). This trench is located southeast of the known area of schroeckingerite mineralization and contains no schroeckingerite deposits. The trench 13 area, however, contains considerable amounts of iron-cemented sandstone as pebbles in float distributed widely over the surface of the ground (pl. 38). Samples of the float contain 0.005 to 0.008 percent equivalent uranium, but only 0.002 to 0.004 percent uranium. The iron-cemented sandstone in place forms the basal contact of the upper lenticular extension of the Tipton tongue. Even though the radioactivity of the samples is not particularly high, the presence of so much surficial material having slightly abnormal radioactivity probably causes an appreciable mass effect that would explain the anomaly detected by airborne equipment.

ORIGIN

The uranium in many of the deposits of other radioactive materials in the general schroeckingerite area was probably deposited in the same manner as the schroeckingerite. Many of the samples of rocks containing these materials are similar to samples containing schroeckingerite in having a higher percentage of uranium than equivalent uranium. Also, much of this material seems to have been deposited either at the same general level as the schroeckingerite deposits or above and below the schroeckingerite deposits. It seems likely that some of these low-grade deposits may represent the sites of former schroeckingerite deposits that have been dissolved and redeposited elsewhere, leaving part of the uranium behind. In other instances, the anomalous concentrations of uranium may represent the sites of incipient mineralization by schroeckingerite.

The iron-cemented sandstone float in the trench 13 area and some of the iron-stained zones along contacts between adjacent beds in other parts of the Lost Creek area are slightly radioactive, but the grade is very low in all occurrences of this type. Many other beds of iron-cemented sandstone and iron-stained bedding planes in the various trenches are essentially nonradioactive. The explanation for abnormal radioactivity in some of the iron-cemented rocks is not known.

The deposition of the iron in the various iron-stained zones and along iron-stained bedding planes may have been partly an original sedimentary or diagenetic feature. Or in some or all instances the iron may represent a much later deposition of ferrous hydroxide from the ground water. The auger-drilling indicated that some of the iron-stained zones persist to as much as 35 feet below the present ground level. If the iron was deposited from ground water, the water level must have been much lower in the past in order to allow the requisite oxidation. Presumably, such a lower water table existed, at least during dry stages of the Pleistocene epoch. The fact that some iron-stained zones along contacts are radioactive whereas others are barren suggests that the formation of the iron oxides was separate and distinct from the uranium deposition. Considerably more work, especially deep drilling, would be necessary to establish the exact relations of the iron-stained zones to the uranium mineralization.

URANIFEROUS WATER

GENERAL FEATURES OF WATER IN THE LOST CREEK AREA

Lost Creek is one of the few streams in the Great Divide Basin where water flows permanently. It is intermittent over most of its course, permanently flowing in appreciable amounts only for about 3 miles in the vicinity of the schroeckingerite deposits. The stream begins to flow a short distance upstream from the point where it crosses a syncline (pl. 36). It flows steadily to about 1 mile below the schroeckingerite deposits. In Osborne Draw (pls. 36 and 37) there is a permanent pond and several marshy areas. A spring at the mouth of Osborne Draw flows throughout the year and there are several springs in the western part of the area, along a large fault. The rest of the area is dry except for seasonal runoff.

Ground water was reached in several of the trenches and in many of the drill holes in the exploration area. The depth to water ranged from a few feet to 46 feet. In several of the deeper drill holes there was a layer of water-saturated rocks at shallow depths, then a thick layer of dry rocks, and more water-saturated rocks at depths of about 30 to 40 feet. Most of the water at shallow depths may represent perched water tables, but their extent is not known. The lack of direct relationship between the level of water in Lost Creek and the level of water in scattered drill holes suggests that Lost Creek in the schroeckingerite area is supplied by rising ground water in the form of seeps and springs, and has no close relation with the ground water table.

WATER SAMPLES

A total of 141 water samples were taken for analysis in the Lost Creek area and surrounding region in order to classify the ground water as to type and to attempt to correlate the origin of the water-soluble schroeckingerite deposits with the type and origin of the water. The following table shows the results of the analyses of these water samples. Forty-one of the samples were given a complete analysis for the common constituents of ground water.

The analysis of water samples from the Lost Creek area indicated that the water has a composition typical of semiarid and arid regions, but with abnormal amounts of uranium, fluorine, and nitrate. The

Results of the analysis of water samples taken in the Lost Creek area and surrounding region, Sweetwater and Fremont Counties, Wyo.

[Chemical analyses were made at Denver, Colo., by Wayne Mountjoy, J. W. T. Meadows, W. W. Niles, J. N. Rosholt, Jr., J. P. Schuch, G. T. Burrow, G. W. Boyes, Jr., Rene F. Dufour, J. S. Wahlberg, and Claude Huffman, Jr.]

Sample No.	Location	Date	Partial composition of water in parts per million										Radium (grams per liter)	Sludge		pH
			Ca	Na	K	CO_3	HCO_3	SO_4	Cl	F	NO_3	U		Per cent U	Weight (grams)	
DS-W-1	Lost Creek, 0.5 mile upstream from the cabin on Lost Creek in schroeckingerite area.	October 1952				10.0	201	260	13.8	0.52	3.7	0.160	1×10^{-12}			8.39
2	Lost Creek, 1.0 mile upstream from cabin.	do				7.3	186	198	15.7	.24	3.9	.032	1×10^{-12}			8.58
3	Lost Creek, 2.3 miles upstream from cabin.	do				9.0	178	142	18.2	.19	1.8	.028	4×10^{-12}			8.66
4	Soda Lake, south edge	do				22.6	292	50,600	7,600.0	.09	3.5	.110	2×10^{-12}			8.41
5	Lost Creek, 4.8 miles north-northeast of Soda Lake.	do				38.3	517	441	58.0	1.82	2.3	.014	2×10^{-12}			8.19
6	Crooks Creek, at bridge in Crooks Gap.	do				10.0	155	29	4.4	.38	2.3	.016	2×10^{-12}			8.41
7	Stock pond (spring), 7.4 miles northwest of cabin.	do				3.7	162	162	6.2	.72	3.0	.020	3×10^{-12}			8.32
8	Picket Lake, south side	do				183.0	1,020	134	114.0	3.39	3.2	.020				9.28
9	Pond in Osborne Draw, 300 yards north of cabin.	do				4.3	143	251	34.9	.86	1.4	.410	3×10^{-12}			8.39
10	Lost Creek, 1.2 miles downstream from cabin.	do				5.7	223	328	18.7	.48	2.8	.046	3×10^{-12}			8.53
11	Lost Creek, by cabin	do				9.0	201	269	15.7	.62	1.9	.056	2×10^{-12}			8.57
12	Spring, 100 yd. north of cabin.	do				1.7	160	90	9.2	.72	1.8	.190	3×10^{-12}			8.33
13	Water well, 3.5 miles south of cabin.	do	48	80	4	6.0	164	187	1.87	.25	61	.090				8.0
14	Lost Creek at Eagles Nest Crossing, 7 miles south of cabin.	do	61	310	7	3.7	260	813	4.01	.44	2.7	.150				8.1
15	Auger hole ES-24	do	95	270	20	2.7	179	921	2.49	.35	32	.080		0.0006	4.88	7.8
16	ES-25	do	41	310	11	<1.0	191	665	4.13	.44	18	.030		.0006	1.36	7.7
17	ES-34	do	39	400	9	<1.0	179	870	6.41	.30	7.4	.080		.0009	1.97	7.8
18	ES-29	do	19	230	5	<1.0	142	429	1.86	.30	5.2	.120				7.9
19	ES-32	do	35	140	7	<1.0	148	291	2.20	.30	5.2	.080		.0011	1.56	7.9
20	ES-39	do				<1.0	809	68	13.30	.79	2.8	.016		.0010	1.65	7.7
21	ES-91	do				11.0	423	7,100	119.00	3.94		5.800	$<10^{-12}$	.0036	1.35	8.0
22	ES-101	do	16	340	7	13.0	385	396	8.15	1.13	18.0	.023		.0021	1.28	8.0
23	ES-105	do	49	100	11	<1.0	184	166	1.76	.59	21.0	.24		.0025	1.50	7.2
24	ES-111	do	28	170	5	6.7	217	238	4.35	.74	3.4	.76		.0024	.69	8.1
25	ES-16	do	32	200	6	<1.0	161	231	11.20	.20	3.9	.21				8.1

26	ES-18	do	36	75	6	3.3	224	77	.93	.30	5.0	.32	--	.0009	.98	8.3
27	ES-86	do	35	120	10	<1.0	437	38	2.09	.44	1.6	.08	--	.0031	2.31	7.6
28	ES-90	do	41	480	6	20.0	635	573	9.43	2.86	2.6	.44	--	.0017	5.33	8.2
29	ES-12	do	40	180	7	8.3	272	220	3.68	<.05	6.2	.52	--	.0011	2.44	8.3
30	ES-115	do	49	300	9	<1.0	314	547	2.99	.69	11.0	.25	--	.0025	6.57	7.8
31	ES-117	do	22	83	4	5.3	160	89	.92	.59	3.9	.30	--	.0010	1.36	8.2
32	Bucket hole 363	do	19	200	16	3.3	373	167	2.17	.30	16.0	.20	--	.0014	5.86	8.4
33	356	do	150	380	20	<1.0	502	1,184	4.42	.35	11.0	.14	--	.0008	10.81	7.5
34	305	do	76	400	8	<1.0	179	965	2.42	.15	38.0	.78	--	.0050	.54	7.6
35	308	do	89	2,500	20	<1.0	264	6,387	52.70	.44	2.6	7.30	$<10^{-12}$	.0080	1.09	7.9
36	311	do	160	500	14	<1.0	230	119	20.90	.25	6.3	3.20	--	.0070	.54	8.1
	Pool, trench 7 (distance from south end):															
37	25 ft	do	--	--	--	10.0	343	5,548	88.00	5.42	1.4	8.00	$<10^{-12}$	--	--	8.4
38	140 ft	do	29	500	6	10.0	188	940	10.10	2.32	2.8	2.00	--	--	--	8.4
39	635 ft	do	36	150	5	<1.0	154	258	3.07	.64	8.8	.60	--	--	--	8.1
40	700 ft	do	35	1,100	9	16.0	226	2,110	12.70	4.93	1.4	3.00	--	--	--	8.4
41	1,190 ft	do	110	6,500	33	<1.0	455	11,569	194.00	6.26	2.4	6.80	--	--	--	8.1
42	1,370 ft	do	58	1,600	9	1.7	251	3,253	39.30	5.37	.86	1.80	--	--	--	8.2
43	1,570 ft	do	17	920	5	16.0	284	1,261	25.40	4.63	.66	1.70	$<10^{-12}$	--	--	8.6
	Pool, trench 8 (distance from south end):															
44	1,410 ft	do	24	185	6	<1.0	142	167	2.94	1.04	17.00	.12	--	--	--	7.7
45	1,670 ft	do	48	400	11	<1.0	70	3,317	10.10	.74	30.00	.56	--	--	--	8.1
46	1,880 ft	do	46	400	6	<1.0	161	842	9.80	.64	9.4	.60	--	--	--	8.1
47	2,060 ft	do	46	400	5.5	<1.0	159	845	9.33	.69	6.6	.60	--	--	--	8.2
48	2,100 ft	do	55	480	7.5	<1.0	156	1,067	11.20	.69	5.2	.98	--	.0015	.38	8.0
49	2,200 ft	do	31	290	7	<1.0	146	524	5.37	.49	5.5	.41	--	--	--	8.0
50	2,310 ft	do	78	6,100	15	22.0	187	12,212	32.80	4.93	2.1	2.60	$<10^{-13}$	--	--	8.2
51	Reversed S-K well, 10 miles southeast of cabin.	do	11	85	6	2.0	136	53	.84	.39	5.3	.020	--	--	--	8.4
52	Crooked Neck Pete Larsen well, 16 miles southeast of cabin.	do	25	220	9	<1.0	201	364	1.66	.59	2.1	.016	--	--	--	7.7
RW-1142	Reversed S-K well, 10 miles southeast of cabin.	1953	8	14	1	0	56	24	.2	.2	.8	.002	--	--	--	7.15
1143	Spring, 100 yd north of cabin.	do	19	20	2	3.3	78	59	2.2	.4	4.7	.180	--	--	--	8.12
1144	Lost Creek, near cabin	do	24	45	1	3.3	87	141	4.4	.3	31.0	.023	--	--	--	8.10
1145	Lost Creek, 2.3 miles upstream from cabin.	do	18	33	2	.8	91	105	6.9	.6	28.0	.027	--	--	--	8.18
BH-1	Bucket hole 6	November 1951	--	--	--	2.0	180	169	19.1	.6	--	.52	--	--	--	8.02
43	64	December 1951	--	--	--	1.3	185	122	12.6	.5	--	.44	--	--	--	7.99
307	60	do	--	--	--	8.3	219	767	86.0	1.3	--	1.30	--	--	--	8.46
309	62	do	--	--	--	<1.0	253	1,799	234.0	.5	--	5.20	--	--	--	7.84
312	66	do	--	--	--	<1.0	174	127	15.3	.4	--	.32	--	--	--	7.98
326	41	do	--	--	--	<1.0	237	248	38.3	1.0	--	.80	--	--	--	8.00
328	43	do	--	--	--	9.0	204	185	24.7	.8	--	.64	--	--	--	8.39
330	45	do	--	--	--	2.0	146	114	12.9	.3	--	.36	--	--	--	8.15
331	47	do	--	--	--	3.3	173	111	9.6	.4	--	.40	--	--	--	8.18
333	49	do	--	--	--	7.3	215	162	39.7	.4	--	.44	--	--	--	8.20
346	23	do	--	--	--	6.9	172	187	18.7	.5	--	.44	--	--	--	8.21

Results of the analysis of water samples taken in the Lost Creek area and surrounding region, Sweetwater and Fremont Counties, Wyo.—Con.

[Chemical analyses were made at Denver, Colo., by Wayne Mountjoy, J. W. T. Meadows, W. W. Niles, J. N. Rosholt, Jr., J. P. Schuch, G. T. Burrow, G. W. Boyes, Jr., Rene F. Dufour, J. S. Wahlberg, and Claude Huffman, Jr.]

Sample No.	Location	Date	Partial composition of water in parts per million										Radium (grams per liter)	Sludge		pH
			Ca	Na	K	CO_3	HCO_3	SO_4	Cl	F	NO_3	U		Percent U	Weight (grams)	
BH-348	Bucket hole 25	December 1951				9.3	423	2,911	252.0	2.6		6.40				8.20
350	27	do				3.7	166	183	20.9	.6		.52				8.09
351	29	do				4.0	165	121	10.4	.5		.76				8.22
353	31	do				3.3	168	391	82.1	.8		.56				8.13
367	2	November 1951				5.0	177	473	22.4	1.3		.68				8.22
369	4	do				4.0	160	196	11.8	.4		.36				8.10
372	8	do				4.0	196	249	38.2	1.1		.68				8.17
374	10	December 1951				<1.0	138	1,379	31.3	1.6		.60				7.80
DS-81	Auger hole ES-81	October 1951				8.3	299		101.0			1.9		0.004	14.7	
82-384	82	do				10.1	302	1,140	394.0	2.34		2.1		.004	16.7	8.34
83-385	83	do				15.4	302		62.4			1.2		.003	9.79	
84-386	84	do				4.3	250	400	17.7	4.68		.48		.002	10.6	8.21
86-387	86	do				2.5	189	98.6	73.9	.38		.40		.003	12.9	8.22
87-388	87	do				6.8	196	428	57.7	1.87		.36		.003	3.70	8.28
88-389	88	do				6.8	199	382	38.3	1.12		.24		.003	3.59	8.20
90-390	90	do				9.7	276	521	81.7	1.40		.68		.003	7.76	8.10
91-391	91	do				15.1	270	3,390	668.0	1.22		4.80		.004	5.93	8.10
92-392	92	do				<1.8	165	536	78.2	1.12		.84		.003	5.43	8.04
93-393	93	do				17.2	356	4,120	1,580.0	1.22		10.80		.005	7.91	8.00
94-394	94	do				7.9	240	1,260	188.0	.84		2.8		.003	34.8	8.08
96-395	96	do				3.6	203	231	17.8	1.03		.48		.003	8.07	8.27
99-396	99	do				5.7	170	290	16.8	.56		.36		.002	6.82	8.43
100-397	100	do				<1.8	184	161	45.2	2.06		.36		.007	9.96	
101-398	101	do				5.4	238	433	64.3	1.97		.76		.003	12.4	8.32
103-399	103	do				8.3	290	339	56.9	1.50		.80		.003	38.0	8.46
104-400	104	do				10.1	300	199	31.4	.94		.68		.002	59.6	8.57
105-401	105	do				<1.8	151	152	13.2	.66		.20		.003	3.47	8.03
106-402	106	do				2.9	162	139	12.2	.66		.32		.003	6.23	8.15
108-403	108	do				25.8	329		131.0			.40		.005	39.40	
109-404	109	do				18.7	320		30.8			.84		.004	11.50	
110-405	110	do				3.2	177	129	12.2	.66		.68		.003	2.50	8.20
111-406	111	do				4.7	210	200	29.1	.47		.48		.003	1.43	8.39
112-407	112	do				2.5	218	118	7.1	.28		.40		.003	16.60	8.25
113-408	113	November 1951				<1.8	201	140	22.5	.75		.36		.004	14.90	7.99
114-409	114	do				7.2	208	355	29.9	.47		.96		.004	6.46	8.38
115-410	115	do				<1.8	250	248	35.7	.47		.36		.003	18.20	8.10
116-411	116	do				4.3	223	704	39.7	.75		2.00		.005	17.80	7.94
117-412	117	do				3.6	170	115	9.1	.28		.36		.003	8.31	8.12
12-413	12	do				3.6	167	231	24.3	.38		.36		.001	5.31	8.10

20-288	20	July 1951				4.0	153.7	86.7	13.1	.70		.209		.006	.65	
35-289	35	August 1951				4.0	114.9	197.1	15.4	.28		.002		.001	.39	
25-290	25	July 1951				2.5	99.7	436.5	22.6	.52		.004		.002	.78	
34-291	34	August 1951				5.0	143.1	835.6	56.9	.19		.112		.002	.23	
33-292	33	do				5.4	208.1	273.1	15.9	.42		.011		.001	.36	
29-293	29	July 1951				5.4	130.7	420.6	17.7	.37		.028		.002	.10	
30-294	30	August 1951				2.9	119.0	288.1	21.3	.47		.034		.002	.33	
32-295	32	do				6.1	131.8	284.4	21.9	.33		.112		.002	.38	
24-296	24	do				4.7	171.2	618.1	13.5	.19		.005		.001	.81	
39-297	39	do				5.0	198.2	256.6	13.1	.33		.019		.001	1.67	
19-310	19	July 1951				12.9	199.7	776.9	122.9	.47		1.600		.003	.64	
15-311	15	do				23.3	682.6	4,188.2	1,861.3	7.69		32.0		.011	.07	
16-312	16	do				5.0	135.4	218.1	65.3	.28		.340		.003	.19	
17-313	17	do				4.0	165.7	71.2	12.1	.33		.168			.25	
18-314	18	do				9.0	167.2	90.2	13.1	.70		.052		.002	.14	
2-199	2	November 1950				11.1	144.2	998.0	22.6			.66				7.85
3-200	3	do				13.5	190.3	932.0	30.8			.42				8.35
4-201	4	do				13.5	134.0	2,035.0	31.2			.60				8.00
5-202	5	do				6.6	162.1	893.0	16.4			.48				8.00
6-203	6	do				8.7	135.9	800.0	15.2			.48				8.20
7-204	7	do				10.0	123.8	1,844.0	28.7			.50				7.90
8-205	8	December 1950				10.6	126.0	751.0	19.5			.14				8.00
9-206	9	do				7.4	134.5	823.0	19.9			.04				7.90
10-207	10	do				9.2	138.0	6,521.0	78.3			.88				8.10
12-208	12	do				14.5	100.5	2,566.0	35.9			.07				8.00
DW-102-296	Pond at mouth of Lost Creek.	1949				2.0	70	103	19			.0				
85-264	Spring, 100 yd north of cabin.	May 1949				7.0	83	127	20			.440				
WNS-10-14	do	July 1949				6.0	136	78	20			.010				
22-30	do	October 1949										.130				
DW-85-265	Lost Creek, near cabin	1949				17	114	54	5			.0				
WNS-3-3	Chain Lake, 17 miles southeast of cabin.	do				242	2,147	1,956	1,960			.030				
7-9	Sourdough Dam, No. 1 Reservoir, 20 miles southeast of cabin.	do				0	102	28	68			.010				
9-13	Pit 14 (Wyant and others, 1956, pl. 19).	do				34	486	6,590	40			46.000				
17-25	Water well, 3.5 miles south of cabin.	do										.030				
21-29	PB spring, 23 miles northwest of cabin.	do										.010				

uranium content of all samples ranges from 0.002 to 46 parts per million, with an average content of about 1.4 parts per million. The uranium content of surface water samples ranges from 0.014 to 0.44 parts per million. The samples with the highest uranium content came from drill holes and prospect pits where the water was close to or in contact with schroeckingerite bodies. The fluorine content of samples of surface water in the Lost Creek area and surrounding areas ranges from 0.09 to 3.39 parts per million, and of samples of ground water from less than 0.05 to 6.2 parts per million. The nitrate content of samples of surface water ranges from 1.4 to 31 parts per million, and of samples of ground water ranges from 0.66 to 61 parts per million.

INTERPRETATION OF WATER ANALYSES

In the interpretation of the water samples from the Lost Creek area, an attempt was made to determine whether or not the waters were entirely meteoric in origin or if there could have been addition of hydrothermal or juvenile water. This was done by classifying the waters according to their chemical values, or reaction capacities, and comparing them with similar classifications of waters from other areas and with waters having known or suspected additions of juvenile water.

Ground waters are chiefly solutions of bicarbonates, sulfates, and chlorides of the alkaline earths and the alkalies. The waters commonly contain some silicon, iron, and aluminum, but these constituents are usually assumed to occur in the colloid state as oxides, and not to be in chemical equilibrium with the constituent ions. The most abundant cation constituents are usually two alkaline earths, calcium and magnesium, and two alkalies, sodium and potassium. The most common anion constituents are the weak acid, bicarbonate, and the two strong acids, sulfate and chloride. For the graphic methods used in this paper, the waters are treated substantially as though they contained only three cation constituents (Ca, Na, K) and three anion constituents (HCO_3, SO_4, Cl).

The reaction capacities of the Lost Creek waters were derived by translating the physical weights (the amounts in parts per million) of the constituents into their chemical values in the solution, expressed as equivalents per million and derived by the following formula (Piper, 1944, p. 915):

$$\text{Equivalents per million} = \text{parts per million} \times \text{valence/atomic weight}$$

The reaction capacity of the constituents of water is their equivalents per million expressed as a percentage of the sum of the equivalents for all the constituents. In substantially all natural waters the cations are in chemical equilibrium with the anions, and if the concentrations of the several dissolved constituents are measured in terms of percentage of reacting value, the subtotals of the cations and the anions should each be 50 percent of the whole.

The statement of a water analysis in terms of ratios, by reacting values of each radical to the sum of all the radicals, is a basic chemical characterization of the water solution. This system of study allows the various constituents to be listed and studied in terms of the reacting value of each constituent and of each group of like constituents. The reacting values of the physical amounts of constituents determine the chemical characteristics of the water studied. These characteristics are often written in terms of salinity or alkalinity, and are derived as indicated in the following diagram:

Bases	Acids	
	Strong acids (Cl, SO_4)	Weak acids (CO_3, HCO_3)
Alkalies (Na, K)	Primary salinity	Primary alkalinity.
Alkaline earths (Ca, Mg)	Secondary salinity	Secondary alkalinity.
Metals (H, Fe)	Tertiary salinity	Tertiary alkalinity.

Figure 33 shows the chemical values from the water analyses plotted as single points according to conventional trilinear coordinates (Piper, 1944, p. 917). In the triangular field at the lower left the percentage reacting values of the three cations (Ca, Na, K) are plotted as a single point. The three anion groups (HCO_3, SO_4, Cl) are plotted in a similar manner in the triangular field at the lower right. The central diamond-shaped field is used to show the overall chemical character of the water by a third single point plotting, which is at the intersection of rays projected from the points in the two triangles. The position of the point in the diamond-shaped field indicates the relative composition of a water in terms of cation-anion pairs that correspond to the four vertices of the field. These three trilinear plottings show the essential chemical character of a water according to the relative concentration of its constituents, but not according to the absolute concentrations.

In most of the Lost Creek analyses salinity exceeds 50 percent. The specimens that have the largest amounts of uranium have a primary salinity in excess of 80 percent, due almost exclusively to the sulfate ion. The highest uranium values occur where the composition of the water matches closely the composition of glauber salt ($NaSO_4$).

Table 2 lists some averages of water analyses from different types of localities in the Lost Creek area and Red Desert compared with some averages of water analyses from other areas. Figure 34 shows

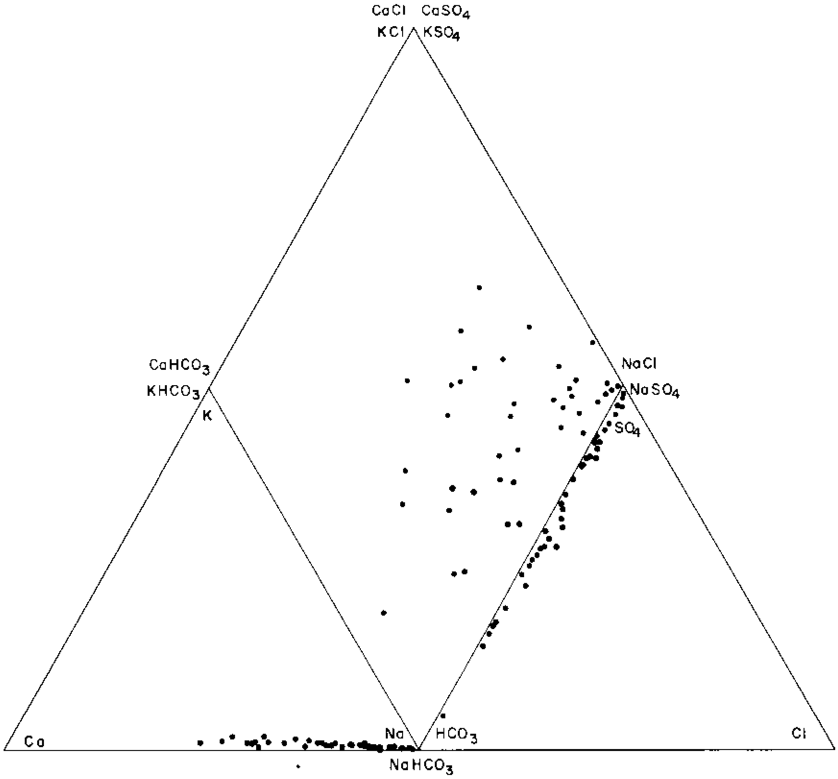

FIGURE 33.—Trilinear diagram showing chemical character of water samples from the Lost Creek area.

the trilinear plot of the chemical values of these analyses. This comparison shows graphically the similarities and dissimilarities of the water from several environments in the Lost Creek area and Red Desert, from similar environments in Montana, and from waters of known volcanic and juvenile associations.

Table 3 shows seasonal and yearly variations in the composition of the water in the Lost Creek area. Analytical data are incomplete, but the table shows that the amounts of the various constituents are subject to wide variation from year to year and from season to season.

CONCLUSIONS

The general composition of the waters of the Lost Creek area, with the exception of abnormal amounts of uranium, fluorine, and nitrate, matches closely the character and composition of ground waters in other arid regions of similar geology. The data are inconclusive as to the ultimate origin of the water. The waters may be entirely meteoric

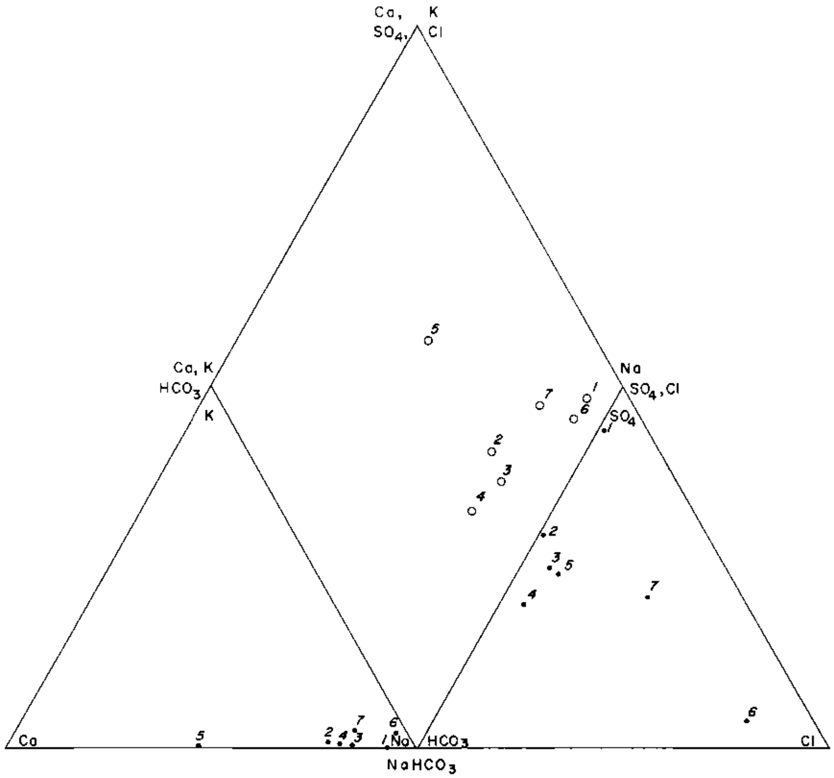

FIGURE 34.—Trilinear diagram comparing water analyses in the Lost Creek area with water analyses from other areas. For location of samples see table 2.

with the major constituents, except uranium, derived from the normal soils and bedrocks of the region. Certain features of the composition, on the other hand, including abnormally high concentrations of fluorine, nitrate, and uranium, suggest a possible addition of juvenile or hydrothermal water to the meteoric waters. However, other areas, notably western Texas, also have abnormal amounts of fluorine, but have no direct evidence for the addition of juvenile or hydrothermal waters. Most water analyses in the United States show a low relative concentration of nitrate, whereas most waters that are probably in part juvenile have abnormally high relative concentrations of nitrate (White and Brannock, 1950, p. 568–570; Peale, 1886; Gooch and Whitfield, 1888; Clarke, 1914; Stearns and others, 1937). In a playa terrane, however, a high relative concentration of nitrate might be expected through the leaching of the small amounts of nitrate from volcanic rocks and its concentration by evaporation in the closed basin. The high uranium content may be due to a hydrothermal addition, or,

TABLE 2.—*Comparison of partial analyses of water samples from the Lost Creek area and Red Desert with those of water from other areas*

No.	Waters from:	Number of specimens	Partial composition of water, in parts per million									pH
				Ca	Na	K	CO_3	HCO_3	SO_4	Cl	F	
1.	Auger holes, bucket holes, and trenches, Lost Creek area.	35	Maximum	160	6,500	33	22.0	869	12,212	194.0	6.26	8.6
			Minimum	16	75	5	<1.0	70	38	.92	<.05	7.2
			Average	52	823	9.3	<4.8	274	1,875	20.8	<1.55	8.25
2.	Wells in the Red Desert	4	Maximum	48	220	9	6.0	201	364	1.87	.59	8.4
			Minimum	8	14	1	<1.0	56	24	.20	.20	7.15
			Average	23	100	5	<2.0	139	157	1.13	.36	7.8
3.	Surface waters from the Red Desert	15	Maximum	61	310	7	183.0	1,020	813	144.0	3.39	9.28
			Minimum	18	20	1	.8	78	29	2.2	.19	8.10
			Average	30.5	102	3	19.5	244	228	23.1	.84	8.41
4.	Fort Union formation in Montana [1]	----------	Maximum	336	----------	920	----------	2,152	2,440	306	----------	----------
			Minimum	4.0	----------	8.0	----------	63	2.6	1.0	----------	----------
			Average	54	----------	286	----------	666	316	33	----------	----------
5.	Surficial deposits in Montana and North Dakota.[1]	142	Maximum	500	----------	880	----------	883	1,600	472	----------	----------
			Minimum	15	----------	4.0	----------	95	12	1.0	----------	----------
			Average	124	----------	140	----------	412	382	58	----------	----------
6.	Steamboat Springs, Nev.[2]	4	Maximum	23	707	81	104	419	131	949	2.2	8.6
			Minimum	3.9	602	56	20	191	105	747	1.6	7.7
			Average	12.9	645	66.6	62	305	118	836	1.9	8.2
7.	Some thermal waters of volcanic association.[3]	7	Maximum	338	1,389	108	173	1,891	1,984	921	22	9.5
			Minimum	2	48	30	0	0	21	5	2.1	2
			Average	61.3	478	57	39	452	628	386	11.7	6.2

[1] Riffenburg, 1925.
[2] Brannock, Fix, Gianella, and White, 1948, p. 221.
[3] White and Brannock, 1950, p. 569.

TABLE 3.—*Comparison of water samples taken from the same location at different times, Lost Creek area*

Sample No.	Location	Date	Partial composition of water, in parts per million										Ra (grams/liter)	pH
			Ca	Na	K	CO_3	HCO_3	SO_4	Cl	F	NO_3	U		
DW-85-264	Spring in schroeckingerite area 100 yd north of cabin.	May 1949	----	----	----	7	83	127	20	----	----	0.440	----	----
WNS-10-14	do	July 1949	----	----	----	6	136	78	20	----	----	.010	----	----
WNS-22-30	do	October 1949	----	----	----	----	----	----	----	----	----	.130	----	----
DS-W-12	do	October 1952	----	----	----	1.7	160	90	9.2	0.72	1.8	.190	3×10⁻¹²	8.33
RW-1143	do	October 1953	19	20	2	3.3	78	59	2.2	.4	4.7	.180	----	8.12
DW-85-265	Lost Creek near cabin	1949	----	----	----	17	114	54	5	----	----	.00	----	----
DS-W-11	do	1952	----	----	----	9.0	201	269	15.7	.62	1.9	.056	2×10⁻¹²	8.57
RW-1144	do	1953	24	45	1	3.3	87	141	4.4	.3	31	.023	----	8.10
DS-W-3	Lost Creek 2.3 miles upstream from cabin.	1952	----	----	----	9.0	178	142	18.2	.19	1.8	.028	4×10⁻¹²	8.66
RW-1145	do	1953	18	33	2	.8	91	105	6.9	.6	28	.027	----	8.18
WNS-17-25	Water well, 3.5 miles south of the cabin.	1949	----	----	----	----	----	----	----	----	----	.030	----	----
DS-W-13	do	1952	48	80	4	6.0	164	187	1.87	.25	61.0	.090	----	8.0
DS-W-51	Reversed S-K well, 10 miles southeast of the cabin.	1952	11	85	6	2.0	136	53	.84	.39	5.3	.020	----	8.4
RW-1142	do	1953	8	14	1	0	56	24	.2	.2	.8	.002	----	7.15

if the waters are entirely meteoric in character, the uranium may have been derived from a uraniferous source rock or deposit.

Whatever the exact source of the waters may be, it is not likely that the uranium was obtained from the present host rocks, the overlying soils, or widespread low-grade sources, because schroeckingerite deposition has not occurred in other places in the Great Divide Basin where lithologic, topographic, and hydrographic conditions, and the water composition, excepting the uranium, are virtually the same. Field evidence concerning the solution and redeposition of schroeckingerite in the Lost Creek area and the laboratory evidence of high uranium content of the waters indicate that water plays a direct part in the formation of the schroeckingerite deposits. The immediate source of the uranium in the schroeckingerite deposits is the uraniferous ground water.

A more detailed and complete study of the ground water in the Lost Creek area would be helpful in finding additional uranium deposits. The source of the flowing water in Lost Creek, whether it is artesian springs or water table, and the direction of movement of the subsurface water may indicate the location of high-grade source deposits.

SUGGESTIONS FOR PROSPECTING

SCHROECKINGERITE

The area containing known deposits of schroeckingerite is shown on plate 37. The distribution of deposits within the mineralized area is incompletely known. It is possible, also, that additional deposits may lie outside the arbitrary boundary line shown on the map. As a possible aid to future prospecting, exploration, or development work, the experiences of the authors in identifying schroeckingerite and in searching for it are summarized below.

Pellets of schroeckingerite, 0.05 inch or more in size, can be identified easily by the characteristic brilliant yellow-green fluorescence and by the appearance in natural light. Smaller pellets and the finer grained types of schroeckingerite are more difficult to distinguish in the field from fluorescent opal, which also has a yellowish color under the ultraviolet lamp. Small acounts of schroeckingerite associated with fluorescent opal and with some types of fluorescent carbonate give the false impression that the fluorescent material is all schroeckingerite. The difficulties in identification are especially pronounced when the material under inspection is in the form of drill cuttings, because the mixing in drill holes commonly breaks the fluorescent material into very fine grains. Identification of some of the very fine grained types of fluorescent material commonly must be done by study under the microscope, but the authors also found that fine specks of fluorescent material of uncertain identity can be rubbed between the fingers for rapid field identification. If the specks were schroeckingerite, they smeared easily on the fingers and the entire smear retained a brilliant yellow-green fluorescence. If, however, the specks were not schroeckingerite, they either did not smear at all, as with hard opal coatings on sand grains, or if they did smear, the fluorescent color of the smeared material diminished in intensity to dull yellow. A hand lens can be used to check the identification by fluorescence, and an added check should also be made with a Geiger-Müller counter. Although the radioactivity of a schroeckingerite is low, nevertheless it is an aid to identification.

The most useful tool for geologic work in connection with schroeckingerite is the ultraviolet lamp. The lamp can be used at night, for example, in marking out the extent of individual blocks of mineralized ground in exploratory trenches or pits. It can also be used advantageously in a portable dark box for examining drill cuttings during daylight drilling operation.

Experience has shown that the Geiger-Müller counter and the scintillation counter are of little value for prospecting for schroeckingerite if the deposits lie below about 1 foot of overburden. The radioactivity of the schroeckingerite is so low relatively, in comparison with other uranium minerals that are closer to radioactive equilibrium, that its presence can be detected with counting devices only in exposures practically at the surface of the ground.

It is difficult to prospect for schroeckingerite deposits in the Lost Creek area without the aid of exploratory work. Methods that have been used in the area include digging test pits, bulldozing, trenching, drilling with an auger and other types of drilling. Of all these methods, trenching gives the most information about the size and shape of the deposits and also provides good exposures for sampling. The other methods, however, can be used very advantageously in determining the presence or absence of schroeckingerite and in marking out details of distribution between trenches.

A limited amount of prospecting can be done without the aid of exploratory methods. Some of the known schroeckingerite deposits lie very close to the surface either where the overburden is thin or where the deposits are partly or wholly within the Quaternary sands and silts. Such deposits are commonly indicated by efflorescent salts that occur at the surface of the ground. Where such salts overlie schroeckingerite deposits they have a definite pale-yellow-green fluorescence. Where such surficial salts are not underlain by schroeckingerite and are not downslope from schroeckingerite deposits, the color under the ultraviolet lamp is merely a white reflection. Night prospecting should be done with caution because the Red Desert has abundant opal-encrusted pebbles that fluoresce yellow or yellow-green.

The known schroeckingerite deposits lie in and near the Cyclone Rim zone of faulting, and the mineralization is generally the richest in siltstone or claystone beds. These geologic associations might aid in further prospecting. Additional exploration work within or near the Cyclone Rim might disclose additional deposits of schroeckingerite. The exploration through 1952, however, disclosed no schroeckingerite west of Lost Creek and none as far southeast as trench 13 (pl. 37). In addition to the immediate vicinity of the Cyclone Rim zone, other possible areas for prospecting include some of the drainages in the area—for example, along Osborne Draw and eastward along that drainage from the area containing schroeckingerite deposits.

HYPOTHETICAL DEPOSITS

The authors believe that the schroeckingerite mineralization in the Lost Creek area can be considered a clue to more important uranium deposits. It is difficult to reconcile the presence of large amounts of schroeckingerite in this area as a unique occurrence involving no other uranium deposits in the immediate vicinity. In many other uraniferous districts in the western states, schroeckingerite occurs as one of a suite of secondary uranium minerals that are often indicators of high-grade ore at depth.

The authors have concluded that the uranium in the Lost Creek schroeckingerite deposits probably was derived from unexposed uranium deposits of relatively high grade whose existence, however, is entirely hypothetical and is based on indirect evidence. Other geologists have voiced equally strong preferences for derivation of the uranium by leaching of large bodies of low-grade source rocks.

Unfortunately these differences of opinion cannot be resolved by using the presently available data, because exploratory activities have been limited almost entirely to the schroeckingerite deposits and the near-surface portion of the area. The existence of the hypothetical high-grade source deposits must be proved or disproved before the economic and scientific aspects of the Lost Creek area can be evaluated fully. The following suggestions, therefore, pertain to several possible methods of solving the problem. These suggestions might be modified or supplemented by the growing fund of geologic data and exploratory experience in several rapidly growing uranium districts elsewhere in Wyoming.

A special study involving the detailed pattern of ground-water movements in the Lost Creek area might offer some clues. Such a study would be especially valuable if it could determine the path of uranium-bearing solutions into the Lost Creek schroeckingerite area.

Another study could be based on exploratory drilling at depths of 250 feet, 500 feet, or even 1,000 feet or more. Such drilling could be based partly on the results of ground-water studies and partly on the presently available geologic data. Gamma-ray logging of all drill holes would be a necessary part of any exploration in order to detect the presence of deposits near to but not cut by the drill holes.

Three general areas in the vicinity of Lost Creek can be considered geologically favorable to the presence of the hypothetical high-grade source deposits:

First, the known area of schroeckingerite mineralization (pl. 37) is a logical place to explore at depth for source deposits. Although drilling in this area discovered no deposits except those of schroeckingerite and other low-grade types of radioactive material, the maximum depth of the drill holes was only 51 feet. Even in some of these shallow holes, gamma-ray logging disclosed unexplained radioactive anomalies. Additional drilling to greater depths in the area of schroeckingerite mineralization could be based partly on the complex fault pattern in the Cyclone Rim zone. The areas between faults and the area north of the zone of faulting should also be considered favorable, however, because the hypothetical deposits might be controlled partly by stratigraphic factors.

A second large area that is geologically favorable lies southeast, east, and northeast of the known area of schroeckingerite mineralization. The surface drainage into much of the area mineralized by schroeckingerite is from these directions, and it might be assumed that ground-water movements, at least in part, also may be directed into the schroeckingerite area from these directions. Deeper drilling in these directions, both within the Cyclone Rim zone of faulting and in the area north of the zone, could be considered.

A third large area is that where there are intersections of major faults. The geologic map (pl. 36) shows that the long northeasterly-trending faults intersect both the Cyclone Rim zone of faulting and the major curving fault on the north limb of the syncline. Comparison of those features to those on plate 37 shows that the area of schroeckingerite mineralization lies very close to the intersections of the long northeasterly and northwesterly faults. Such a location is similar to the structural associations of many types of ore deposits. It may be considered geologically favorable, therefore, to drill the various major fault intersections in this vicinity. Drilling also might be considered along the faults away from the intersections.

Another supplementary study that conceivably might be of value involves geophysical techniques in searching for concealed ore deposits.

However, the complex intertonguing of shale and sandstone in the area might pose technical difficulties for some geophysical methods.

If concealed high-grade uranium deposits are eventually found in the Lost Creek area and if these deposits are associated with faults, it would be logical to prospect on a structural basis beyond the limits of the Lost Creek area. As the fault system in the Lost Creek area is probably part of a major regional fault system extending both northwest and southeast for a total distance of about 75 miles, prospecting and exploration could be extended in both directions from the Lost Creek area. It is also conceivable that northeasterly faults in the Lost Creek area may extend northeast towards the Crooks Gap uranium district; such structures could also be investigated.

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STRATIGRAPHIC SECTIONS IN THE LOST CREEK AREA

Section 1. Stratigraphic section of Tipton tongue of Green River formation and Battle Spring formation, undifferentiated, as exposed in trench 12

	Feet
Sandstone, silty, pale-green; mottled with maroon to green sandy siltstone	5
Claystone, sandy, brown-gray	1.8
Sandstone, fine-grained to coarse-grained, pebbly, brown-white to white	19
Claystone, sandy, blocky, brown-gray	1.5
Sandstone, coarse-grained, pebbly, brown-white; minor amounts of interbedded brown-gray claystone	4.5
Claystone, blocky, maroon to brown-gray	1
Siltstone, clayey, buff-white; contains 0.5-inch layer of maroon claystone in center of unit	.5
Shale, gray-green	1.2
Shale, green-black, carbonaceous(?)	.5
Shale, maroon	.5
Sandstone, coarse-grained, pebbly, brown-white	6
Claystone, sandy, brown-gray; maroon at base	1.2
Siltstone, clayey, brown-white to red-white	.8
Shale, maroon to gray	.8
Sandstone, fine- to coarse-grained, pebbly, gray-white to brown-white; interbedded with brown-gray sandy claystone	13.5
Sandstone, poorly sorted, pale-brown	6
Sandstone, pebbly, gray	9
Claystone, sandy, brown-gray; interbedded with gray sandstone	2.5
Sandstone, coarse-grained, gray, irregularly iron stained	1
Sandstone, fine-grained, gray-white	1
Sandstone, pale-brown; contains 4 in. of red stain at base	1
Sandstone, gray-white	2.2
Sandstone, silty, red-white	.8
Sandstone, coarse-grained, gray-white; has minor irregular lenses of brown-gray sandy claystone near top and irregularly distributed iron-oxide and manganese-oxide stains	9
Total thickness of measured section	90.3

Lower beds not exposed.

Section 2. Stratigraphic section of Cathedral Bluffs tongue of Wasatch formation and Battle Spring formation, undifferentiated, as partially exposed in trench 8

	Feet
Shale, green; interbedded with green subfissile to blocky claystone and green and gray-green siltstone	100
Siltstone interbedded with sandy siltstone and claystone; rocks range in color from tan to light green	65
Siltstone, buff and green; interbedded with fine- to medium-grained buff and tan sandstone	60
Claystone, green; interbedded with buff, green, and olive-green siltstone	145
Sandstone, coarse-grained and pebbly, white and tan	55
Siltstone and fine-grained sandstone, green, green-white, and buff	70
Sandstone, silty, buff-brown; interbedded irregularly with gray-green sandy siltstone	4.5
Siltstone, sandy; mottled gray-green and maroon	7.5
Sandstone, coarse-grained, buff-white	.8
Siltstone, sandy; mottled gray-green and maroon	5.5
Sandstone, poorly sorted, buff-white to buff; contains lenses of white cemented sandstone, 1 ft. in length	12
Sandstone, medium- to coarse-grained, green-white to buff; interbedded irregularly with pale-brown, gray-brown, and green siltstone	23
Sandstone, silty, green-brown to buff; irregularly iron-stained at base	12
Siltstone, partly sandy, mottled green, gray-green, maroon and gray-brown	12
Sandstone, pebbly, brown-white; contains minor amounts of interbedded green-brown sandy siltstone	17
Sandstone, pebbly, brown-white; interbedded irregularly with green-brown sandy siltstone	8
Sandstone, coarse-grained, pebbly, brown-white, iron-stained at base	11
Siltstone, pale-green-brown to gray-green	10
Sandstone, medium-grained to pebbly, brown-white to buff-white	12
Sandstone, silty, pale-green-brown, lenticular	8
Sandstone, medium-grained to pebbly, brown-white to buff-white	13
Siltstone and clayey siltstone, green to brown-green	22
Sandstone, coarse-grained, buff-white; iron-stained at top and at base, lenticular	2.5
Siltstone and clayey siltstone, green to brown-green	12
Sandstone, medium- to coarse-grained, brown-white; interbedded irregularly with gray-green to green-brown sandy siltstone	10
Claystone, silty, mottled green, maroon-brown, and brown-green; iron-stained at base; contains minor lenses of brown-green fine-grained sandstone	5
Siltstone, brown-gray	2
Sandstone, pebbly, brown-white to buff-white	36
Siltstone, partly sandy and partly clayey, gray-brown, green, and brown-green; interbedded irregularly with green sandstone near base	29
Sandstone, pebbly, brown-white	5
Claystone, sandy, maroon-brown, gray-green, and brown-green; interbedded irregularly with green-white to pale-brown-green poorly sorted sandstone	10
Sandstone, coarse-grained, brown-white to green-white	4

Section 2. Stratigraphic section of Cathedral Bluffs tongue of Wasatch formation and Battle Spring formation, undifferentiated, as partially exposed in trench 8—Continued

	Feet
Claystone, sandy, mottled, brown-green and maroon-brown; contains minor lenses of brown-green silty sandstone; iron-stained at base	26
Sandstone, pebbly, brown-white to gray-white	17
Claystone, maroon-brown, iron-stained at top	.2
Claystone, sandy, green to gray-green; contains minor irregularly interbedded brown-white fine-grained sandstone near top	28
Covered interval, deep alluvium along Lost Creek. The lithologic character of the Cathedral Bluffs tongue in this area is not known in detail, but nearby auger holes indicate that the covered interval consists partly of interbedded gray-green, brown-gray, gray, and chocolate-brown claystone and siltstone and gray, gray-white, green-white, buff-white, and yellow-buff silty to pebbly sandstone; approximate thickness	275
Siltstone, sandy, gray-green to brown-green, iron-stained at base	4
Sandstone, pebbly, gray-white	10
Sandstone, pebbly, brown-white to pale-green	36
Sandstone, silty; mottled green-gray and maroon-gray	1
Claystone, blocky, gray-green to brown-green; contains rosettes of gypsum	7
Sandstone, medium-grained, buff-white to gray-white, interbedded irregularly with maroon-gray to green-gray sandy siltstone	7
Covered interval, probably sandstone as above and below	3
Sandstone, medium-grained, buff-white to gray-white, interbedded irregularly with maroon-gray to green-gray sandy siltstone	5
Sandstone, pebbly, brown-white to buff-white	10
Sandstone, silty, green-gray to maroon-gray, mottled with gray-white coarse-grained sandstone	4
Sandstone, pebbly, brown-white	7
Sandstone, silty, green-gray; maroon at top and at base	3
Sandstone, pebbly, brown-white; contains minor amounts of irregularly interbedded gray-green to maroon-gray sandy siltstone	5
Claystone, mostly blocky but partly subfissile, gray-green to brown-green mottled with purple, iron-stained at top and at base; contains limestone concretions and geodes, 0.5–5 in. in diameter; also contains minor lenses of brown-white pebbly sandstone and gray-green to maroon-gray sandy siltstone	7
Sandstone, medium-grained to pebbly, gray-white, interbedded irregularly with buff-green silty fine grained sandstone	8
Sandstone, cemented, red-gray	.5
Sandstone, pebbly, crossbedded, gray-white	8
Sandstone, medium- to coarse-grained, crossbedded, brown-gray	7
Sandstone, pebbly, crossbedded, gray-white to brown-gray; contains varicolored clay galls along the crossbedding	8
Siltstone and sandy siltstone, gray-green and brown-green, interlensed irregularly with green-gray, maroon-gray, brown-white, and green-white fine- to medium-grained sandstone	10
Sandstone, fine-grained, green-gray to maroon-gray, iron-stained at base	1.5
Claystone, mostly blocky but partly subfissile, gray-green; contains limestone concretions, 3 to 6 in. in diameter	4.5

Section 2. Stratigraphic section of Cathedral Bluffs tongue of Wasatch formation and Battle Spring formation, undifferentiated, as partially exposed in trench 8—Continued

	Feet
Claystone, blocky, dark-gray	0.4
Claystone, mostly blocky but partly subfissile, gray-green, iron-stained at base	2
Sandstone, pebbly, gray-white; partly crossbedded, with brown-gray clay galls along crossbedding	2.5
Sandstone, silty, brown-green; maroon at top and at base	.2
Sandstone, coarse-grained, pebbly, crossbedded, brown-gray, maroon-gray, gray-white, and brown-white; contains gray clay galls along crossbedding	6
Sandstone, coarse-grained, pebbly, gray-white	1.5
Siltstone, sandy, brown-gray and maroon-gray	.5
Sandstone, coarse-grained, pebbly, gray-white	3
Sandstone, silty, brown-gray; 1-ft-thick lens of gray-white pebbly sandstone 1 ft above base	4.5
Sandstone, coarse-grained, pebbly, gray-white	5.5
Sandstone, silty, and sandy siltstone; mottled brown-green and gray-green; layers of maroon-gray silty sandstone, 2.5 in thick, at top and at base	2.2
Sandstone, coarse-grained, gray-white	4
Sandstone, silty, and sandy siltstone; mottled brown-green and gray-green; layers of maroon-gray silty sandstone, 2.5 in thick, at top and at base	1.8
Sandstone, coarse-grained, pebbly, gray-white	8
Fault interval. Thickness of missing section unknown	--
Sandstone, coarse-grained, pebbly, gray-white; iron-stained near base	3
Shale, brown-gray to gray; finely interbedded with brown-white to red-gray fine-grained sandstone; jarositic stains near base; discontinuous seams of lignite, one-eighth in. thick, along base	2
Total thickness of section	1,338.6

Section 3. Stratigraphic section of Cathedral Bluffs tongue of Wasatch formation and Battle Spring formation, undifferentiated, as partly exposed in trenches 6 and 11

Covered interval north of trench 11, approximate composition and thicknesses as follows:

	Feet
Shale, green; interbedded with green subfissile to blocky claystone and green and gray-green siltstone	105
Siltstone and sandy siltstone, tan, buff, and light-green	50
Sandstone, coarse-grained and pebbly, gray, buff, and white	60
Siltstone and claystone, olive-green	20
Sandstone, coarse-grained and pebbly, white and tan	55
Siltstone, green and buff	30
Sandstone, coarse-grained, white	50
Claystone and siltstone; mottled green, brown, and tan	30
Sandstone, medium-grained, white and buff	35
Siltstone, green; interbedded with green and maroon blocky claystone	35

Section 3. Stratigraphic section of Cathedral Bluffs tongue of Wasatch formation and Battle Spring formation, undifferentiated, as partly exposed in trenches 6 and 11—Continued

Trench 11:

	Feet
Covered interval north of trench 11—Continued	
Sandstone, poorly sorted, fine- to coarse-grained pebbly, brown-white; parts of the sandstone in the form of lenses, 6 in.–4 ft in length; well cemented by carbonate	12
Claystone, silty, blocky; mottled maroon and gray-green	2
Siltstone, pale-brown in upper part, green at base	.5
Claystone, blocky; mottled maroon and gray-green	16
Siltstone, sandy, gray-green	3
Sandstone, fine- to coarse-grained, pebbly, brown-white	16
Siltstone, sandy, gray-green; lens of brown-white to green-white sandstone, 2 ft thick, 4 ft above base, with one calcite-cemented concretion, 1.5 ft in diameter, containing 0.25- to 0.5-in concretions of pyrite	20
Sandstone, brown-white to green-white; contains sparse carbonate-cemented sandstone lenses, 6 in–2 ft in length; irregular lens of gray-green sandy siltstone, at least 5 ft in maximum thickness in center of unit; unit iron-stained at base	13
Claystone, sandy; gray-green mottled with maroon-brown, interbedded irregularly with brown-green siltstone	26
Claystone, sandy; gray-green mottled with maroon-brown, interbedded irregularly with brown-green siltstone and lenses of brown-white sandstone; iron-stained at base	12
Sandstone, coarse-grained pebbly, brown-white, with minor interbedded gray-white fine-grained sandstone; iron-stained at base	17
Claystone, silty, blocky, green-gray	6
Siltstone and silty sandstone, irregularly interbedded, green and gray-green	29
Siltstone, maroon-gray, iron-stained at top and at base	2.5
Claystone and sandy claystone, irregularly interbedded, green and gray-green; contains two lenses of brown-white sandstone	19
Faulted interval. Thickness of missing section unknown.	
Claystone and sandy claystone, irregularly interbedded, green and gray-green	7
Siltstone, clayey, green-gray and gray-brown; interbedded irregularly with pale-brown fine-grained sandstone	8
Sandstone, coarse-grained, pebbly, brown-white	10
Faulted interval. Thickness of missing section unknown.	
Sandstone, coarse-grained, pebbly, brown-white	23
Sandstone, coarse-grained, pebbly, iron-stained, with thinly interbedded brown-green claystone	.5
Sandstone, coarse-grained, pebbly, brown-white, with minor amounts of interbedded pale-brown siltstone	14
Claystone, silty, blocky, green-gray, interbedded irregularly with brown-white sandstone	9
Sandstone, coarse-grained, pebbly, brown-white	14

Section 3. Stratigraphic section of Cathedral Bluffs tongue of Wasatch formation and Battle Spring formation, undifferentiated, as partly exposed in trenches 6 and 11—Continued

Trench 11—Continued	
Covered interval, between trenches 11 and 6, approximate composition and thicknesses as follows:	*Feet*
Sandstone, coarse-grained, white and brown-white	25
Siltstone, gray-green and brown	20
Sandstone, coarse-grained, brown-white	45
Claystone, green; interbedded with gray-green and brown siltstone	50
Siltstone, gray-green and brown; interbedded with green-white and buff-white fine-grained sandstone	70
Sandstone, coarse-grained, brown-white and white	50
Claystone, green, interbedded with buff and green siltstone	20
Siltstone, buff and green-white, interbedded with buff and tan fine-grained sandstone	65
Sandstone, buff-white	110
Claystone, green; interbedded with buff, brown, and pale-green siltstone and sandy siltstone	65
Trench 6:	
Siltstone, sandy, pale-brown	1
Shale, bright-red	2
Siltstone, clayey, dull-brown and dull-green	4
Siltstone, sandy, pale-green	6
Sandstone, coarse-grained, pale-gray-green	5
Siltstone, clayey, dark-gray and pale-maroon	1.5
Siltstone, pale-maroon; mottled irregularly with pale-green sandstone	.5
Sandstone, medium-grained, pale-green-gray	1
Siltstone, pale-maroon and pale-green	5
Sandstone, medium-grained, pale green-gray	1.5
Siltstone, pale-maroon and pale-green	2.5
Sandstone, partly silty, fine-grained, gray-green	7
Sandstone, fine-grained, pale-green; interbedded irregularly with pale-maroon and pale-brown siltstone	9
Claystone, dark-brown and pale-green, iron-stained at top	2.5
Siltstone, light-tan; contains minor amounts of interbedded medium-grained sandstone	8
Siltstone, clayey, brown	3
Sandstone, medium-grained, heavily iron stained	.8
Sandstone, medium- to coarse-grained pebbly, pale-green-gray	10
Siltstone, sandy, light-brown	.2
Sandstone, poorly sorted (silty to very coarse-grained), pale-gray-green	12
Siltstone, clayey, pale-maroon-brown; with minor amounts of gray-green fine-grained sandstone	1
Sandstone, fine- to coarse-grained, pale-gray-green	9
Claystone, dark-brown and dark-green	6.5
Siltstone, clayey, pale-maroon and green; interbedded with pale-green fine-grained sandstone	4.5
Sandstone, fine- to coarse-grained, pale-gray, white, and brown-white	23
Sandstone, gray-white to brown-white, mottled with irregular masses of gray-green and pale-maroon siltstone	3

Section 3. Stratigraphic section of Cathedral Bluffs tongue of Wasatch formation and Battle Spring formation, undifferentiated, as partly exposed in trenches 6 and 11—Continued

Trench 6—Continued	Feet
Claystone, silty, green, pale-maroon, and gray-green mottled irregularly with gray-green and green-brown siltstone, partly sandy	7
Sandstone, medium- to coarse-grained, brown-white to green-white, with minor amounts of similarly colored sandy siltstone	4
Siltstone, clayey, pale-brown, gray-green, and pale-maroon	1
Sandstone, fine- to medium-grained, brown to brown-white; mottled with green-gray and pale-brown sandy siltstone	4
Sandstone, white, green-white, and brown-white	1.5
Siltstone, green-gray and pale-maroon; mottled irregularly with pale-green-brown silty sandstone	1.5
Claystone, silty, and sandy siltstone; mottled gray-green, maroon, and brown-gray	1.5
Sandstone, medium-grained, brown-white	2
Claystone, silty, and sandy siltstone, mottled gray-green, maroon, and brown-gray	1.8
Sandstone, medium- to coarse-grained, pale-brown to green-white	7
Siltstone, and sandy siltstone, gray-green and maroon	2.5
Sandstone, medium-grained, green-white to white	1
Siltstone and sandy siltstone, gray-green and maroon	1.5
Sandstone, medium- to coarse-grained, gray to light-brown	9
Siltstone, sandy, pale-green	1.5
Sandstone, coarse-grained, yellow-tan	2
Siltstone, sandy, pale-maroon, pale-purple, and pale-green	4
Sandstone, coarse-grained, gray-green	3
Siltstone, mottled pale-purple and pale-green with minor amounts of pale-green to tan fine- to coarse-grained sandstone	2
Sandstone, well sorted, interbedded fine-grained and coarse-grained, pebbly, pale-brown-green, irregularly iron-stained	2.5
Siltstone, clayey, pale-green	.5
Sandstone, well-sorted, interbedded fine- and coarse-grained, pale-brown	3.5
Claystone, dark-green-gray; iron-stained at top	.8
Sandstone, coarse-grained, light-brown	1
Siltstone, clayey, pale-green to purple; with minor amounts of interbedded pale-brown fine-grained sandstone	1
Sandstone, medium- to coarse-grained, gray-green; contains irregular lenses of green and purple clayey siltstone	9
Siltstone, clayey, gray-green and purple-maroon, with minor amounts of interbedded fine-grained sandstone	13
Sandstone, fine- to medium-grained, pale-green; iron-stained at base	3
Claystone, blocky, green	1
Siltstone, pale-brown-gray, irregularly iron-stained at top and at base	.2
Claystone, blocky; and green and gray-green silty claystone	6
Shale, dark-green-brown to dark-brown-gray; 1 in. of gray-purple claystone at top; iron-stained at base of unit	.8
Sandstone, tan	.2
Sandstone, gray-green; complexly and irregularly interbedded with pale-maroon and gray-green sandy siltstone	8.5

Section 3. Stratigraphic section of Cathedral Bluffs tongue of Wasatch formation and Battle Spring formation, undifferentiated, as partly exposed in trenches 6 and 11—Continued

Trench 6—Continued	*Feet*
Siltstone, maroon and gray-green	0.8
Sandstone, coarse-grained, green-white	1
Siltstone, maroon and gray-green	1
Sandstone, fine- to medium-grained, gray-green	.5
Siltstone, sandy, gray-green	1
Siltstone, maroon	.2
Siltstone and sandy siltstone, gray-green, pale-green, and minor amounts of maroon	6
Sandstone, pebbly, gray-white to green-white	10
Sandstone, pebbly, gray-brown to brown-black	1
Sandstone, pebbly, gray-white to green-white	3
Siltstone and sandy siltstone, maroon-gray, brown-green, and gray-green, lenticular and discontinuous	1
Sandstone, pebbly, gray-white to green-white	2
Sandstone, medium- to coarse-grained, green-gray	3.8
Siltstone, dark-green; purple at top and at base; interbedded with lenticular pale-green-gray fine- to medium-grained sandstone	1.8
Sandstone, medium-grained to very coarse grained, gray-green	5
Claystone, silty, dark green-brown	.8
Sandstone, medium-grained, yellow-tan, iron-stained at base	.8
Claystone, silty, dark-green-brown	1.5
Claystone, purple	.2
Claystone, dark-gray and dark-blue-gray, silty near top	4.5
Sandstone, medium-grained to very coarse grained, gray; iron-stained in upper part	7.5
Sandstone, medium-grained, pale-brown	.5
Claystone, dark-brown-green, iron-stained at top	3
Sandstone, medium-grained, light-tan; iron-stained at top	1
Siltstone, dark-green and brown; with minor interbedded blue-green fine-grained sandstone; 2 ft above base is a lens of gray to yellow-tan fine- to medium-grained sandstone, 1 ft thick	9
Sandstone, fine- to coarse-grained, gray-green; near base contains lenticular masses, 1–3 ft in length, of pale-orange-brown well-cemented sandstone	3.5
Sandstone, medium-grained to very coarse grained, pebbly, yellow-tan to green-gray	10
Siltstone, clayey, dark-green and dark-brown with irregularly interbedded green to gray-green fine-grained sandstone; contains lenticular masses, 1–3 ft in length, of pale orange-brown well-cemented sandstone near top	9
Sandstone, medium- to coarse-grained, pale-yellow and pale-green-brown; minor dark green-gray claystone	5
Claystone, dark-green-gray	.5
Sandstone, fine- to coarse-grained, gray-green; minor amounts of interbedded brown siltstone	4.5
Sandstone, fine- to coarse-grained, pale-green, interbedded as lenses with pale-brown siltstone	3.5
Siltstone, clayey, dark-brown	.5

Section 3. Stratigraphic section of Cathedral Bluffs tongue of Wasatch formation and Battle Spring formation, undifferentiated, as partly exposed in trenches 6 and 11—Continued

Trench 6—continued	*Feet*
Sandstone, fine- to coarse-grained, gray-green	1.5
Siltstone, clayey, dark-purple-brown and dark-green; contains interlensed pale-yellow-brown and green-gray fine- to coarse-grained sandstone	2.5
Sandstone, fine- to coarse-grained, pale-yellow-brown and green-gray	4.8
Siltstone, clayey, purple-brown and brown-green	1
Sandstone, fine- to coarse-grained, brown-green	1.5
Siltstone, brown	.8
Sandstone, fine- to coarse-grained, brown-green	2
Siltstone, brown	.5
Sandstone, medium- to coarse-grained, green-gray; minor amounts of interbedded brown siltstone	3.8
Siltstone, clayey, dark-purple-brown	.5
Sandstone, medium- to coarse-grained, yellowish-green-gray	2
Sandstone, fine-grained, gray-green; with dark-brown clayey siltstone at top of unit	.8
Sandstone, medium- to coarse-grained, green-gray	.8
Claystone, silty, maroon-brown, maroon-green, and purple; minor amounts of iron stain and pale-green sandstone	1.5
Sandstone, fine- to medium-grained, gray-green	1.8
Claystone, silty, maroon-brown to maroon-gray, irregular	.2
Sandstone, fine- to medium-grained, gray-green	.5
Claystone, silty, gray-green and maroon-brown	1.5
Sandstone, green-white, interbedded with maroon-brown, maroon, and maroon-gray silty claystone; a discontinuous yellow-white to red-gray sandstone, 3 in thick at base	5.5
Claystone, silty, yellow-white, lenticular	.5
Total thickness of section	1,645

Section 4. Statigraphic section of Cathedral Bluffs tongue of Wasatch formation and Battle Spring formation, undifferentiated, as partly exposed in trench 3

	Feet
Sandstone, green; interbedded with maroon siltstone	11
Claystone, sandy, brown	1.8
Sandstone, coarse-grained, silty, yellow-brown	15
Siltstone, maroon; iron-stained at base	1
Sandstone, coarse-grained, green-gray	3.8
Sandstone, coarse-grained, gray, interbedded with pale-maroon siltstone	4.5
Shale, bright-maroon	1.8
Siltstone, sandy, gray	4.5
Sandstone, silty, coarse-grained, yellow-gray	10
Claystone, brown; minor amounts of interbedded pale-green silty sandstone	10
Sandstone, silty, coarse-grained, gray	15
Claystone, brown, discontinuous	.2
Sandstone, silty, coarse-grained, gray	5
Siltstone, brown; minor amounts of interbedded green sandstone	3

Section 4. Stratigraphic section of Cathedral Bluffs tongue of Wasatch formation and Battle Spring formation, undifferentiated, as partly exposed in trench 3—Continued

	Feet
Claystone, brown; iron-stained at top	0.5
Claystone, maroon; interbedded irregularly with green standstone and yellow-brown silty sandstone	10
Claystone, brown; iron-stained at top	1
Claystone, maroon; interbedded irregularly with green sandstone and yellow-brown silty sandstone	7
Sandstone, coarse-grained, yellow-brown and gray	29
Sandstone, silty, fine-grained, green	.8
Claystone, blocky, green, brown, and yellow, iron-stained at top	8
Siltstone, sandy, yellow-gray	10
Sandstone, coarse-grained, pebbly, gray and green-gray	16
Faulted interval. Thickness of missing section unknown	--
Sandstone, silty, fine- to coarse-grained, gray; contains minor lenses of pale-brown sandy siltstone	15
Shale, dark-brown; iron-stained at top and at base	.2
Sandstone, silty, light-brown; pale green at base	1.8
Claystone, dark-brown	2
Siltstone, sandy, pale-maroon	1.5
Sandstone, coarse-grained, pebbly, pale-green-gray; iron-stained at top	8.5
Siltstone, brown, green, and red; interbedded with gray and green fine- to coarse-grained sandstone; iron-stained at top	31
Claystone, purple-brown and dull-green; iron-stained at top	11
Siltstone, sandy, brown and green	1.2
Sandstone, silty, fine-grained, pale-green; iron-stained at top	2
Siltstone, light-brown	4
Sandstone, coarse-grained, brown-gray	3
Sandstone, fine-grained, pale-brown	5
Faulted interval. Thickness of missing section unknown	--
Sandstone, fine-grained, pale-brown	1
Sandstone, pale-green; minor amounts of interbedded siltstone	2.5
Claystone, brown; iron-stained at top	4
Sandstone, silty, pale-brown-green	5
Siltstone, green and brown	1.5
Siltstone, green-brown; interbedded with maroon and dark-green clayey siltstone and green-brown fine- to coarse-grained sandstone; iron-stained at top	7
Siltstone, clayey, brown and dark-green; iron-stained at top	2.5
Sandstone, coarse-grained, pebbly, pale-green to gray, with a tongue of brown and dark-green clayey siltstone near top	5
Sandstone, fine- to coarse-grained, pale-green, interbedded with brown siltstone	14
Siltstone, clayey, brown-green, iron-stained at top	5.5
Sandstone, fine-grained, brown-gray	6
Sandstone, coarse-grained, green-brown	11
Sandstone, green-brown to brown-green; interbedded irregularly with maroon-brown and green claystone	11
Sandstone, coarse-grained, white to green-white, lenticular, irregular in thickness; brick-red iron-stain at base	4

Section 4. Stratigraphic section of Cathedral Bluffs tongue of Wasatch formation and Battle Spring formation, undifferentiated, as partly exposed in trench 3—Continued

	Feet
Siltstone; interbedded with sandstone, both pale green; lenticular with irregular brick-red iron-stain at base	1.5
Claystone, green-brown; with irregular lenses of pale-green and brown-white sandstone	3.5
Sandstone, pale-green; irregularly iron-stained	7
Sandstone, coarse-grained, pale-green and brown-green interbedded with pale-green fine-grained sandstone	8.5
Siltstone, sandy, brown-green	1
Sandstone, coarse-grained, pale-brown-green and light-brown	1.2
Claystone, pale-brown-green and maroon; interbedded irregularly with pale-brown-green sandstone; iron-stained at base	3
Claystone, blocky, dark-brown-green to gray-green	4
Sandstone, brown-white to green-white, iron-stained at top and at base	.8
Claystone, brown-green to brown-gray	8
Sandstone, green-white to gray-white; with small lenses of claystone	7
Claystone, blocky, gray-green; minor amounts of interbedded sandstone	1.2
Sandstone, silty, gray-green	6
Claystone and sandy claystone, gray-green	2.5
Claystone, light-brown, brown-purple at top and at base	.2
Claystone and sandy claystone, gray-green	1.2
Sandstone, green-white to white, interbedded irregularly with gray-green and light-brown siltstone	11
Sandstone, green-gray, interbedded irregularly with mottled maroon-gray and green-gray siltstone	11
Sandstone, white, brown-white, and green-white; iron-stained at top and at base	.8
Claystone, yellow-green, iron-stained; at base is a layer of purple claystone, 1 in. thick	1.2
Shale, gray to brown-green; has discontinuous lenses of brown-white sandstone, 0.8-ft thick, about 0.2 ft above base	3.8
Sandstone, white; with pale-green and maroon clayey sandstone distributed irregularly at top and at base, irregular	.5
Total thickness of measured section	420

Section 5. Stratigraphic section of Cathedral Bluffs tongue of Wasatch formation and Battle Spring formation, undifferentiated, as partly exposed in trench 12.

	Feet
Sandstone, coarse-grained, pebbly, gray-white	24
Claystone, sandy, green and maroon	2.5
Sandstone, coarse-grained, pebbly, white	14
Sandstone, coarse-grained, brown-white to white, interbedded with irregular lenses of mottled green, maroon, and pale-brown sandy claystone	12
Claystone, sandy; mottled green, maroon, and pale-brown; interbedded with green-white sandstone	9
Sandstone, coarse-grained, green-white to brown-white	5

Section 5. Stratigraphic section of Cathedral Bluffs tongue of Wasatch formation and Battle Spring formation, undifferentiated, as party exposed in trench 12—Continued

	Feet
Siltstone, sandy, brown-green and maroon-gray; interbedded irregularly with green-white silty sandstone	9
Sandstone, pebbly, green-white	1
Sandstone, silty, brown-green and maroon-gray	1
Sandstone, pebbly, green-white	4.5
Siltstone, sandy, and silty sandstone; mottled gray green, maroon gray, and buff brown	2.5
Sandstone, pebbly, gray-white	3.5
Siltstone, sandy, and silty sandstone; mottled gray green, maroon gray, and buff brown	8
Sandstone, fine- to coarse-grained, pebbly, brown-white	7.5
Siltstone, sandy; and silty sandstone, mottled gray green, maroon gray, and buff brown	14
Sandstone, medium- to coarse-grained, pebbly, green-white	2.5
Sandstone, silty, brown-green and maroon-gray; interbedded with brown-green sandy claystone	7.5
Sandstone, pebbly, green-white	1.2
Sandstone, coarse-grained, pale-green; with minor amounts of interbedded varicolored siltstone	14
Claystone, sandy, gray-green, maroon-gray, and buff-brown; interbedded with green-white sandstone	3.2
Sandstone, coarse-grained, pale-brown-green	6
Claystone, sandy, gray-green, maroon-gray, and buff-brown; interbedded with green-white sandstone	13
Sandstone, gray-green; minor amounts of interbedded maroon siltstone	9.5
Siltstone, sandy, pale-brown and maroon-gray, interbedded irregularly with pale-green sandstone; at top is layer of maroon-brown claystone, 1 in-6 in thick	8
Sandstone, coarse-grained, white	9
Siltstone, gray-green and maroon-gray; interbedded with green-white sandstone	16
Sandstone, coarse-grained, green-white	3.5
Siltstone, gray-green and maroon-gray; interbedded with green-white sandstone	15
Sandstone, coarse-grained, green-white	6.5
Claystone, blocky, dark-maroon-gray	2
Sandstone, fine- to coarse-grained, green-white to pale-green	15
Siltstone, sandy, gray-green and maroon-gray, interbedded with green-white sandstone	15
Sandstone, green-white, with minor amounts of interbedded siltstone	13
Siltstone, sandy, gray-green and maroon-gray; interbedded with green-white sandstone	6.5
Sandstone, green-white; with minor amounts of interbedded siltstone	10
Sandstone, green-white; interbedded with gray-green and maroon-gray sandy siltstone	9
Sandstone, green-white; with minor amounts of interbedded siltstone	6.5
Sandstone, green-white; interbedded with gray-green and maroon-gray sandy siltstone	23

Section 5. Stratigraphic section of Cathedral Bluffs tongue of Wasatch formation and Battle Spring formation, undifferentiated, as partly exposed in trench 12—Continued

	Feet
Claystone, blocky, green-gray	3
Sandstone, green-white; interbedded with brown-green to gray-green sandy siltstone	4
Claystone, blocky, gray	.5
Sandstone, green-white, interbedded with brown-green to gray-green sandy siltstone	14.5
Total thickness of measured section	354.4

Section 6. Stratigraphic section of Battle Spring formation as partly exposed in trench 13

	Feet
Claystone, sandy, blocky; mottled brown-gray and maroon-gray; contains irregular discontinuous layers of iron-cemented sandstone, 0.5 to 1 in. thick; discontinuous layer of iron-cemented sandstone, 1 in. thick, at base	10
Sandstone, poorly sorted, medium-grained to pebbly, red-gray to yellow-white; contains sparse carbonate-cemented sandstone concretions, 4–12 in. in diameter	8
Sandstone, silty, gray, lenticular	1.5
Sandstone, poorly sorted, medium-grained to pebbly, red-gray to yellow-white; contains one irregular lens of buff-green silty sandstone, at least 4 ft thick; base of unit iron-stained	18
Sandstone, silty, buff-green; irregular lens of brown-gray clayey siltstone about 0.5 ft thick at base	5
Sandstone, pebbly, poorly sorted, red-gray to gray-brown; contains sparse carbonate-cemented concretions, 6 to 12 in. in diameter	12
Sandstone, silty, buff-green; red-brown, iron-stained sandstone, 1 in. thick at base	5
Sandstone, coarse-grained, pebbly, brown-gray; contains sparse carbonate-cemented sandstone concretions, 6 in. in diameter	18
Sandstone, clayey, gray-brown, lenticular	3
Sandstone, coarse-grained, pebbly, gray; irregularly iron-stained, heavy stain near base	9
Sandstone, coarse-grained, pale-brown	1
Claystone, silty, blocky, gray to brown-gray; contains lenses of pale red-brown to brown-white fine- to coarse-grained sandstone, 6 ft. in maximum thickness	10
Sandstone, fine-grained and brown-gray in upper part, grading to coarse-grained and pale-brown in lower part; contains one lens of brown-gray silty claystone 0.5 ft thick	[1] 22
Sandstone, silty, pale-brown, irregularly interfingered with next unit below	5
Claystone, silty, blocky, pale-green-gray; contains maroon blocky claystone layers, 1–2 in. thick, along lenticular contacts; contains lenses of brown, gray, and brown-white sandstone, as much at 3 ft thick	10
Sandstone, pale-green-white, gray, and brown-white; coarse-grained in upper part, fine-grained in lower part	10

[1] Thickness only approximate. Bed is cut by a fault, displacement along which is unknown.

Section 6. Stratigraphic section of Battle Spring formation as partly exposed in trench 13—Continued

	Feet
Sandstone; well-sorted with pebbly layers alternating with finer grained layers; contains one lens of gray clayey siltstone, 1 ft thick; discontinuous lens of gray to gray-brown blocky claystone, 0.5 ft thick at base	[1] 18
Sandstone, silty, brown-gray	6
Siltstone, clayey, brown-gray; very irregular and interfingered with lenses of brown-white sandstone	7
Sandstone, fine-grained; green-gray in upper part, coarse-grained and pale-brown to red-brown in lower part	[2] 30
Claystone, gray	2
Sandstone, white to brown-gray	6
Faulted part of section. Thickness of missing part of section unknown.	
Claystone, silty, and siltstone; mottled gray, pale-brown, and maroon	3
Sandstone, fine-grained, iron-stained, gray to brown-white; finely interbedded with siltstone	.5
Total thickness of measured section	220

Section 7. Stratigraphic section of extension of Tipton tongue of Green River formation as exposed in trench 8

	Feet
Shale, brown-green to brown-gray, iron-stained	1.7
Shale, brown-green	1
Sandstone, fine-grained, biotitic, gray	.2
Shale, brown-green to gray-green; contains limestone concretions, 1.5 in. thick and 5 in long	3.5
Sandstone, fine-grained, gray-white	.2
Shale, brown to brown-gray; contains a 1.5-in. layer of green-gray clayey fine-grained sandstone, 1.7 ft above base; shale above sandstone layer is iron-stained	2.5
Claystone, waxy, bentonitic, cream-colored	.2
Shale, brown to brown-gray	2+
Faulted part of section. Thickness of missing part of section unknown.	
Total thickness of measured section	11.3

Section 8. Stratigraphic section of extension of Tipton tongue of Green River formation as exposed in trench 3

	Feet
Shale, brown and brown-gray, iron-stained; contains discontinuous seam of gypsiferous lignite, 1 in. thick, 3.5 ft above base; jarositic stains near top	5.5
Shale, brown and brown-gray	3.5
Claystone, waxy, bentonitic, tan, iron-stained	.2
Shale, brown and brown-gray	6
Claystone, pale-green	.5

[1] Thickness only approximate. The unit is cut by faults; displacement is known on only one of the faults.

[2] Thickness only approximate. Unit is cut by numerous faults, the displacement along which are unknown.

Section 8. Stratigraphic section of extension of Tipton tongue of Green River formation as exposed in trench 3—Continued

	Feet
Shale, brown and brown-gray; at base is an iron-stained, light-brown layer of silty sandstone, 1.5 in. thick	6.5
Claystone, blocky, yellow-green to yellow-brown, iron-stained; contains limestone concretions, 0.5–3 in. in diameter	1.2
Shale, brown; fossil locality No. 1 is 3.5 ft below top	7
Sandstone, cemented, white, iron-stained; irregular in thickness	.3
Shale, brown	1.2
Sandstone, cemented, white, iron-stained, irregular in thickness	.3
Faulted interval. Thickness of missing section unknown.	
Claystone, blocky, green, iron-stained; contains irregular lenses of limestone	13
Faulted interval. Thickness of missing section unknown.	
Shale, brown	25
Total thickness of measured section	70.2
Lower beds not exposed.	

Section 9. Stratigraphic section of extension of Tipton tongue of Green River formation as exposed in trench 12

	Feet
Shale, brown-green	1.5
Claystone, waxy, bentonitic, gray	.2
Shale, brown	4
Claystone, bentonitic, green-white	.3
Shale, brown	7
Sandstone, partly cemented, gray-white; iron-stained at top and at base	.7
Shale, brown to brown-gray; contains a discontinuous seam of lignite, one-fourth inch thick, 0.5 ft below top	10
Faulted interval. Thickness of missing section unknown.	
Claystone, sandy, brown-green, interbedded with gray-white sandstone	4
Sandstone, brown-white, iron-stained at base; contains a cemented sandstone lens, 1 ft long, and minor interbedded gray claystone	5
Shale, gray-green; partly blocky near top	6
Claystone, bentonitic, green-white	.2
Shale, gray-green	1.3
Shale, brown, iron-stained at base	12.5
Total thickness of measured section	52.7

Section 10. Stratigraphic section of extension of Tipton tongue of Green River formation as exposed in trench 13

	Feet
Shale, pale-brown, gray-brown, and brown-gray	2
Sandstone, fine-grained, green; bed lenses out updip	.2
Shale, pale-brown, gray-brown, and brown-gray; 0.5-in. layer of green-gray sandy biotitic claystone 1.2 ft above base	2
Claystone, gypsiferous, gray-white	.1
Shale, gray-brown, iron-stained	1
Claystone, waxy, bentonitic, cream-colored	.2

Section 10. Stratigraphic section of extension of Tipton tongue of Green River formation as exposed in trench 13—Continued

	Feet
Shale, pale-brown, gray-brown, and brown-gray; contains minor amounts of yellow-brown silty claystone in layers 1 in. thick; a discontinuous iron-stained layer in the shale with an average thickness of 9 in., 1–2 ft below the top of the unit	12
Claystone, waxy, bentonitic, cream-colored; bed lenses out updip	.2
Shale, pale-brown, gray-brown, and brown-gray; contains minor amounts of yellow-brown silty claystone in layers 1 in. thick	1.2
Shale, brown and gray-brown, iron-stained; discontinuous layer of brown and red-brown iron-cemented sandstone at base with average thickness of 1 in	1.5
Total thickness of measured section	20.4

Section 11. Stratigraphic section of Morrow Creek member of Green River formation, as exposed on south limb of syncline along Cyclone Rim east of Lost Creek and north of Osborne Draw

	Feet
Limestone, green-brown to green-white; partly sandy and partly clayey, partly silicified with lobate algal structures (fossil locality no. 5, table 1)	.8
Claystone, silty, blocky, green-brown; contains limestone nodules	13.5
Covered interval. Composed predominantly of brown and brown-green siltstone interbedded with thin layers of buff-white fine-grained well-sorted sandstone	18
Sandstone, medium- to coarse-grained, gray to pale green-brown; weathers white; well cemented but only part of the cement is carbonate, rest of cement is silica or hardened clay; fossiliferous (fossil locality no. 2, table 1) but fossil content is discontinuous along strike of bed: forms cap rock of much of the Cyclone Rim east of Lost Creek and forms north-facing dip slopes	4.8
Sandstone, fine- to medium-grained, friable, brown-white to white	8
Claystone, silty, gray	2.2
Sandstone, fine- to medium-grained, well-cemented (silica), gray	.5
Claystone, pale-green; fissile in upper part and blocky in lower part	2.2
Siltstone, clayey, brown-gray; contains limestone nodules three-fourths of an inch in diameter	10.5
Sandstone, fine-grained, white, massive; well-cemented by carbonate	1.8
Sandstone, fine-grained, friable, gray	3.2
Sandstone, medium-grained, massive, well-cemented, white	.8
Siltstone, brown-gray	2
Sandstone, fine- to medium-grained, pale-brown-white; well cemented by carbonate, fossiliferous	.5
Sandstone, brown-white, friable; contains a layer of green-gray shale, 2 in. thick, in middle of bed	3.5
Sandstone, medium-grained, white, massive, cemented	.5
Siltstone, clayey, creamy-white to brown-white, partly fissile	21

Section 11. Stratigraphic section of Morrow Creek member of Green River formation, as exposed on south limb of syncline along Cyclone Rim east of Lost Creek and north of Osborne Draw—Continued

	Feet
Covered interval composed of interbedded green fissile claystone, brown-gray and green-gray siltstone, and brown-white and white friable medium-grained sandstone; about 50 percent claystone, 30 percent siltstone, and 20 percent sandstone; base of Morrow Creek member assigned to a thin cemented sandstone bed, which overlies green claystone of the Cathedral Bluffs tongue in the area to the east of the section (projected to the section on the basis of float)	145
Total thickness of measured section	238.8

Section 12. Stratigraphic section of Bridger formation, as exposed just east of Lost Creek on south limb of syncline

	Feet
Claystone, subfissile, green to brown-green, biotitic	1
Covered interval. Approximate composition: green and gray-green micaceous siltstone interbedded with shaly green claystone, scattered small lenses of limestone, and thin beds of well-sorted fine-grained sandstone	23
Claystone, generally calcareous and locally silicified, pale-green-yellow; contains turtle fragments; the continuation of this bed on the north side of the syncline contains algal structures (fossile locality no. 7, pl. 36); algal structures lacking on south side of syncline; forms ridges locally	1
Siltstone, siliceous, gray to brown-gray, massive; possibly tuffaceous(?), breaks with conchoidal fracture	12.5
Sandstone, medium-grained, pale-brown-gray, biotitic; poorly cemented by carbonate, possibly tuffaceous(?)	4.5
Limestone, siliceous, white; minor amounts of biotitic material	.8
Sandstone, medium-grained, gray-brown, biotitic, friable	1
Limestone, siliceous, brown-white	.5
Sandstone, medium-grained, biotitic, friable; brown-gray in upper part, green-gray in lower part	5.7
Sandstone, fine-grained, silty, gray, biotitic, tuffaceous, massive; well cemented by carbonate	2
Sandstone, medium-grained, brown-gray to brown-green, iron-stained, biotitic, friable	5.2
Siltstone, clayey, brown-gray, subfissile	6
Siltstone, silicified, green to green-gray	4
Sandstone, fine-grained, brown-gray, biotitic, friable	2.8
Claystone, grey-green, blocky	2
Limestone, argillaceous, white; contains abundant ostracodes	.8
Claystone, gray-green, blocky	2.2
Limestone, argillaceous, silicified(?), white to brown-white	.5
Sandstone, fine-grained, brown-green, biotitic, friable	1.5
Covered interval, approximate composition and thicknesses as follows:	
Claystone, blocky, gray-green, interbedded with green to gray-green micaceous siltstone	26
Sandstone, fine-grained, friable, light-brown-green, interbedded with green to gray-green siltstone	25

Section 12. Stratigraphic section of Bridger formation, as exposed just east of Lost Creek on south limb of syncline—Continued

	Feet
Covered interval, etc.—Continued	
Claystone, blocky, gray-green, interbedded with green to gray-green micaceous siltstone	33
Sandstone, fine-grained, friable, light-brown-green, interbedded with green to gray-green siltstone	22
Siltstone, brown and green-brown	8
Limestone, argillaceous, white and brown-white	2
Siltstone, brown and green-brown	10
Limestone, argillaceous, partly silicified, white and brown-white; local algal structures	4
Siltstone, subfissile, green	35
Total thickness of measured section	242

INDEX

U. S. GOVERNMENT PRINTING OFFICE : 1961 O - 592548

Contributions to the Geology of Uranium 1958

GEOLOGICAL SURVEY BULLETIN 1087

This bulletin was printed as separate chapters A–J

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1961

UNITED STATES DEPARTMENT OF THE INTERIOR

STEWART L. UDALL, *Secretary*

GEOLOGICAL SURVEY

Thomas B. Nolan, *Director*

CONTENTS

[The letters in parentheses preceding the titles designate separately published reports]

1087

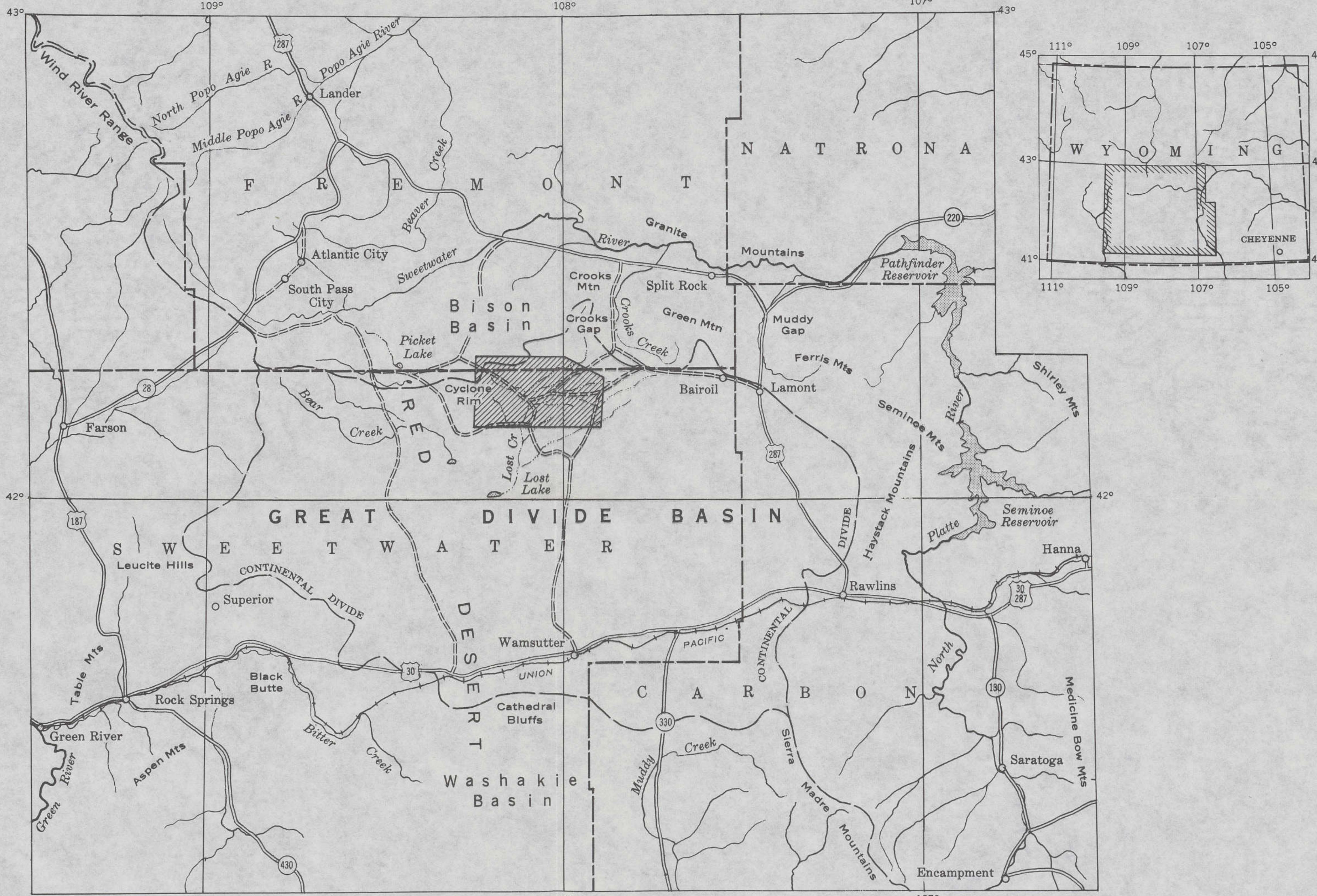
CONTRIBUTIONS TO THE GEOLOGY OF URANIUM, 1958—Geological Survey Bulletin

TEXT

1087

CONTRIBUTIONS TO THE GEOLOGY OF URANIUM, 1958—Geological Survey Bulletin

PLATES



INDEX MAP SHOWING LOCATION OF LOST CREEK AREA,
SWEETWATER AND FREMONT COUNTIES, WYOMING

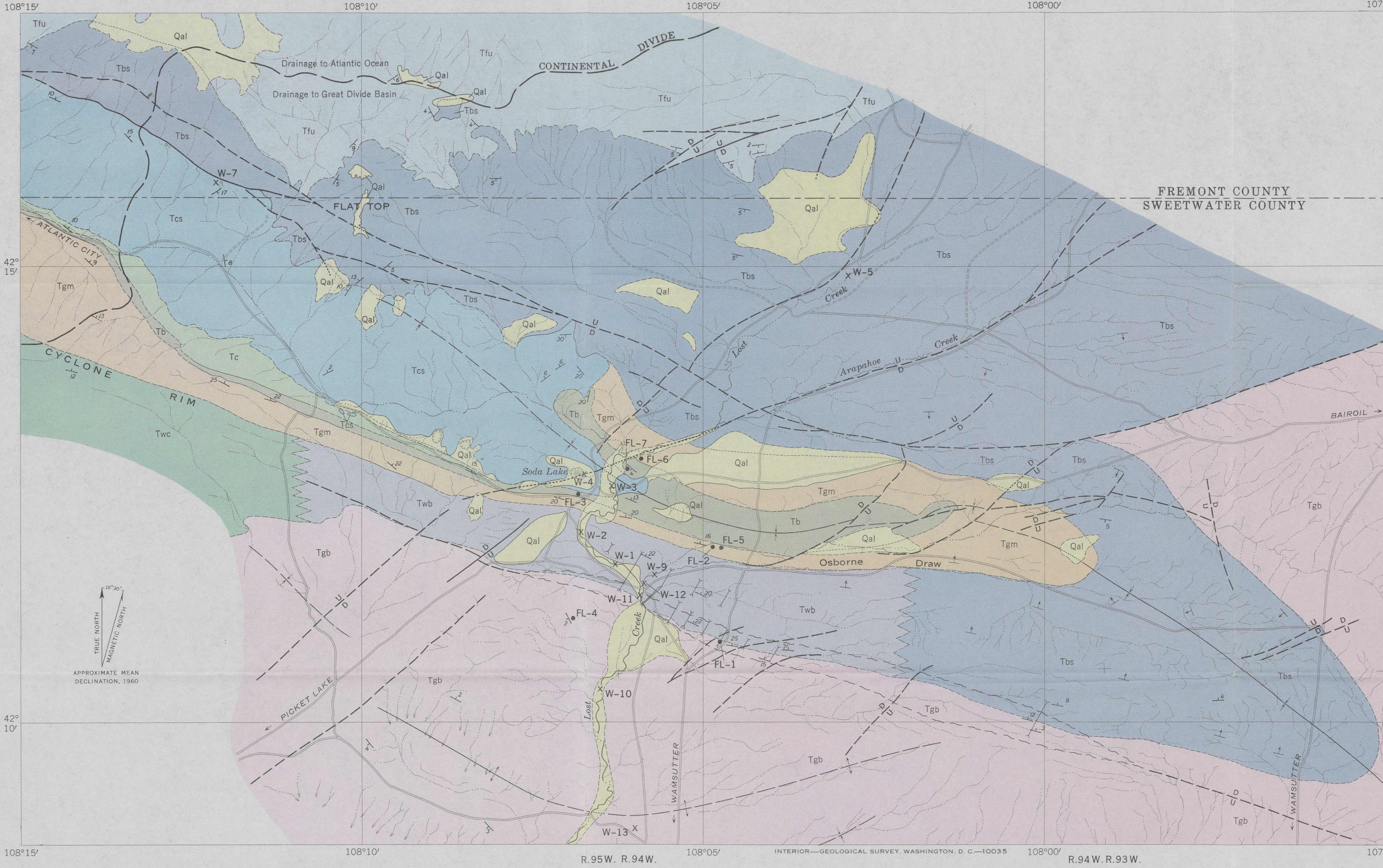
Scale 1: 1 000 000

10 0 10 20 Miles

592548 O No. 1

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

BULLETIN 1087
PLATE 36



Map compiled by C. H. Maxwell, partly by photointerpretation and partly from field data collected by D.M. Sheridan, C. H. Maxwell, and J. T. Collier, 1952, and G. N. Pipiringos and H. Masursky, 1951–52

AREAL GEOLOGY OF THE LOST CREEK AREA, SWEETWATER AND FREMONT COUNTIES, WYOMING

Scale 1:63 360

1 0 1 2 3 Miles

EXPLANATION

QUATERNARY

Pleistocene(?) and Recent

Qal
Alluvium, colluvium, and terrace deposits

UNCONFORMITY

TERTIARY

Miocene

Tcs
Conglomerate, sandstone, marl, clay, and volcanic ash

UNCONFORMITY

Oligocene(?)

Tc
Conglomerate

UNCONFORMITY

Eocene

Tb
Bridger formation

UNCONFORMITY

Tgm, Twb, Twc, Tbs, Tgb
Green River, Wasatch, and Battle Spring formations

Morrow Creek member of Green River formation, Tgm; *Cathedral Bluffs tongue of Wasatch formation,* Twc; *Battle Spring formation and Cathedral Bluffs tongue of Wasatch formation, undifferentiated,* Twb; *Battle Spring formation,* Tbs; *Tipton tongue of Green River formation and Battle Spring formation, undifferentiated,* Tgb

UNCONFORMITY

Paleocene

Tfu
Fort Union formation

Contact
Dashed where inferred, dotted where concealed

Fault
Dashed where inferred, dotted where concealed. U, *upthrown side;* D, *downthrown side*

Approximate limits of Cyclone Rim zone of faulting

Anticline
Showing trace of axial plane, dashed where inferred, dotted where concealed

Syncline
Showing trace of axial plane, dashed where inferred, dotted where concealed

Strike and dip of beds

Strike and dip of beds
Determined from aerial photographs

Exploratory trench

FL-2
Fossil locality

W-2
Water sample

Dry lake depression

GEOLOGIC MAP AND CROSS SECTIONS OF THE LOST CREEK SCHROECKINGERITE AREA AND VICINITY, SWEETWATER COUNTY, WYOMING

Scale 1:9600

800 0 800 1600 2400 3200 4000 Feet

Contour interval 10 feet
Datum is approximate mean sea level

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.—10035

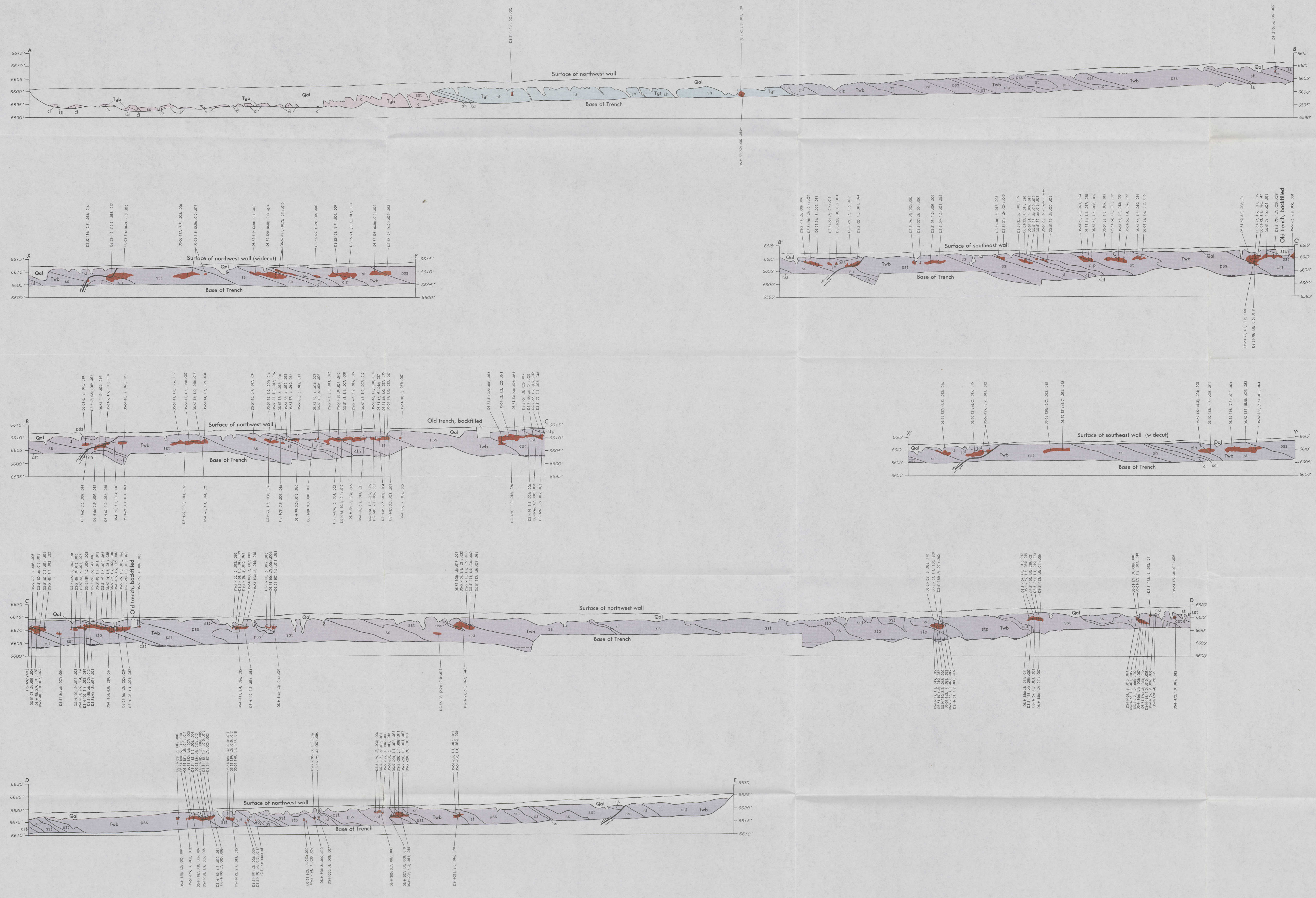
Geology and topography by D. M. Sheridan, C. H. Maxwell, J. T. Collier, and L. R. Page, 1952

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.—10035

DETAILED MAP OF EXPLORATION AREA, LOST CREEK SCHROECKINGERITE DEPOSITS, SWEETWATER COUNTY, WYOMING

Scale 1:4800
400 0 400 800 1200 1600 2000 Feet

Contour interval 5 feet
Datum is approximate mean sea level



EXPLANATION

Pleistocene(?) and Recent — QUATERNARY

Qal
Overburden
Alluvium, colluvium, and terrace deposits

UNCONFORMITY

Eocene — TERTIARY

Twb
Cathedral Bluffs tongue of Wasatch formation and Battle Spring formation, undifferentiated

Tgt
Tipton tongue of Green River formation

Tgb
Tipton tongue of Green River formation and Battle Spring formation, undifferentiated

LITHOLOGIC UNITS

Letter symbols used to designate lithologic units within a Tertiary formation

Shale, sh; *claystone, massive and blocky, poorly fissile,* cl; *sandy claystone or clayey sandstone, also interbedded sandstone and claystone when individual beds are less than 1 foot thick, and complexly mottled and interlensed beds of claystone and sandstone,* scl; *interbedded claystone and pebbly sandstone,* clp; *silty claystone or clayey siltstone, also interbedded siltstone and claystone when individual beds are less than 1 foot thick, and complexly mottled and interlensed beds of siltstone and claystone,* cst; *siltstone,* st; *sandy siltstone or silty sandstone, also interbedded sandstone and siltstone when individual beds are less than 1 foot thick, and complexly mottled and interlensed beds of sandstone and siltstone,* sst; *interbedded siltstone and pebbly sandstone, and pebbly sandstone mottled with irregular lenses of siltstone,* stp; *sandstone,* ss; *pebbly sandstone.* pss

Contact

Fault
Arrows show apparent direction of relative movement

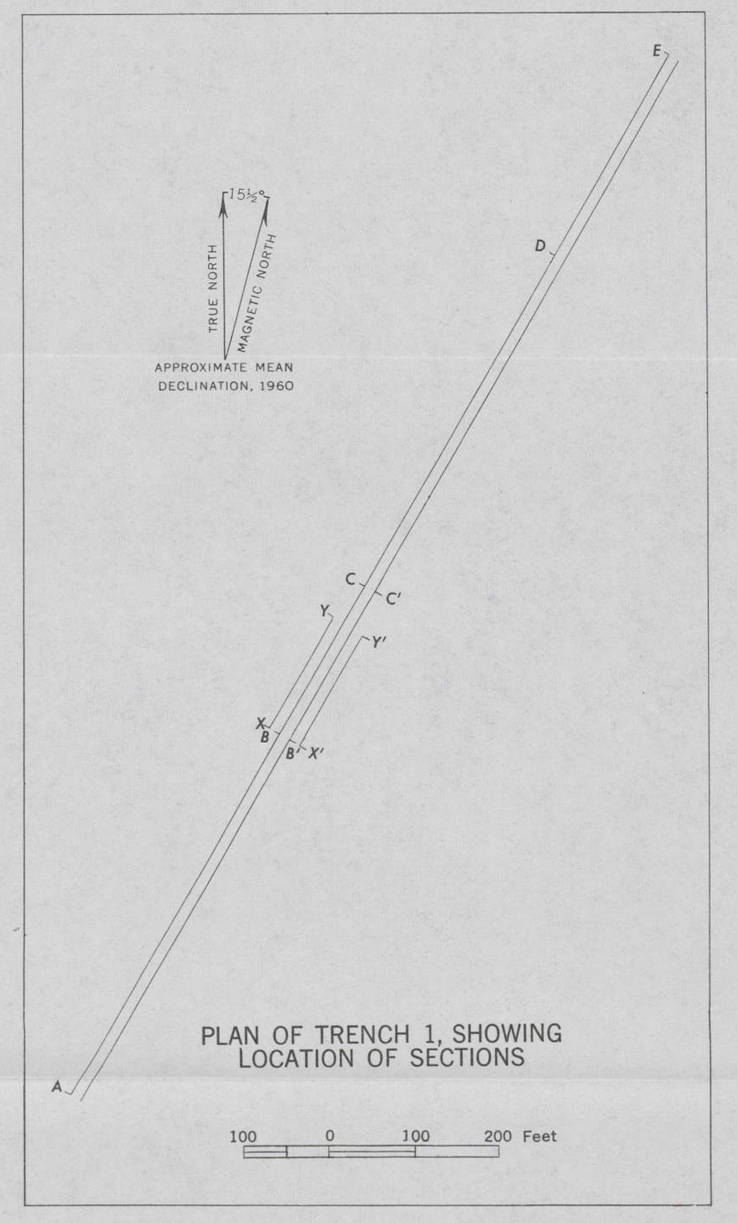
Schroeckingerite deposit
Dotted lines within certain deposits indicate areas differing in schroeckingerite content

DS-52-131; (6.0); .015; .015
Face-cut sample in schroeckingerite deposit
Number of sample; (area of sample in square feet); percent equivalent uranium; percent uranium

DS-51-73; 1.3; .026; .042
Vertical channel sample in schroeckingerite deposit
Number of sample; length of sample in feet; percent equivalent uranium; percent uranium

DS-H-94; 10.0; .018; .026
Horizontal or slightly inclined channel samples in host rock and in schroeckingerite deposit
Number of sample; length of sample in feet; percent equivalent uranium; percent uranium

Water level in trench



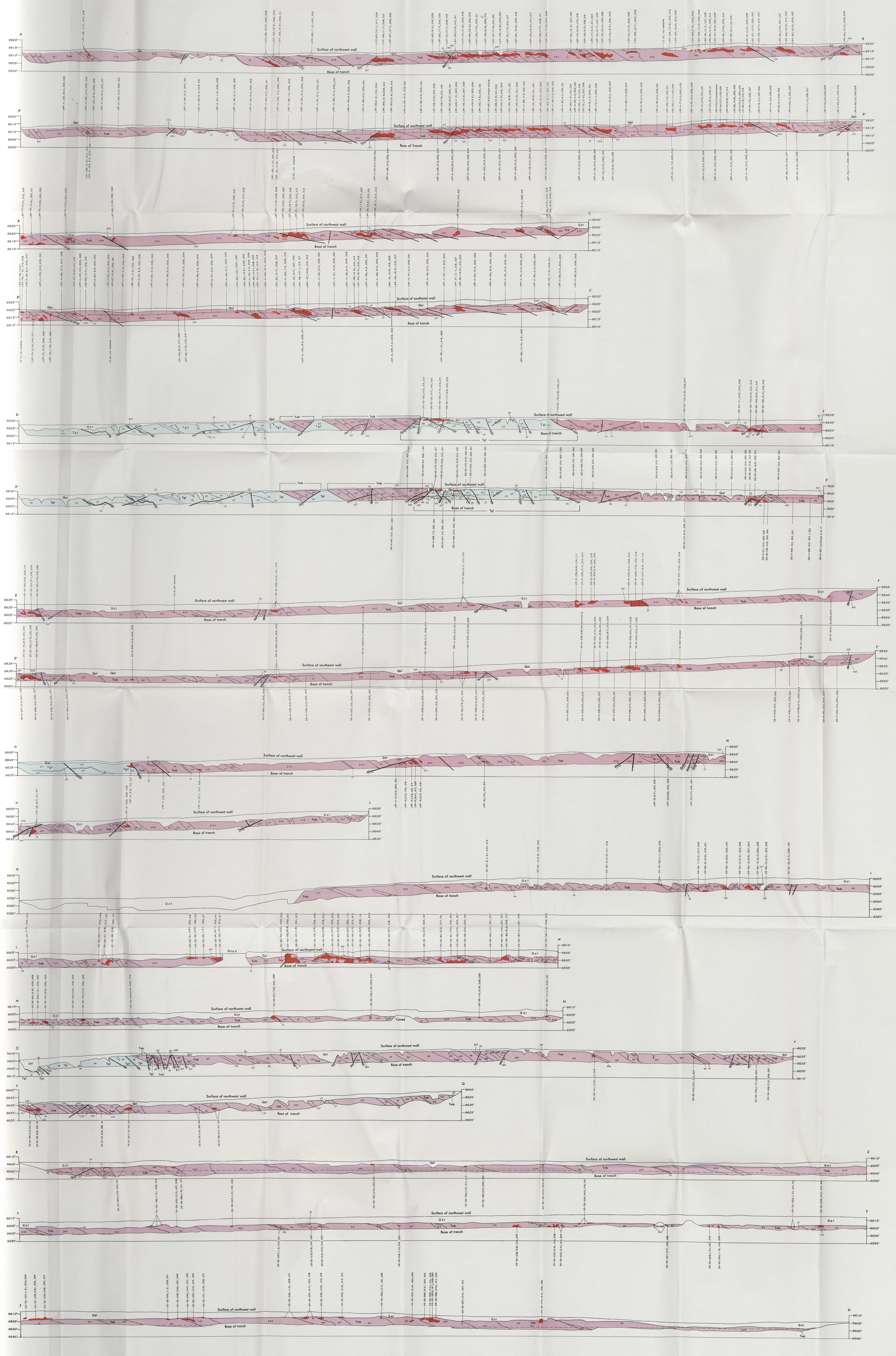
PLAN OF TRENCH 1, SHOWING LOCATION OF SECTIONS

Geology by D. M. Sheridan, R. S. Sears, J. T. Collier, and W. S. Cavender, December 1951–January 1952

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.—10035

GEOLOGIC SECTIONS OF TRENCH 1, LOST CREEK SCHROECKINGERITE DEPOSITS, SWEETWATER COUNTY, WYOMING

Scale 1:240
20 0 20 40 60 80 100 Feet
Datum is approximate mean sea level



EXPLANATION

Pleistocene(?) and Recent — QUATERNARY

Qal
Overburden
Alluvium, colluvium, and terrace deposits

UNCONFORMITY

Eocene — TERTIARY

Twb
Cathedral Bluffs tongue of Wasatch formation and Battle Spring formation, undifferentiated

Tgt
Tipton tongue of Green River formation

LITHOLOGIC UNITS

Letter symbols used to designate lithologic units within a Tertiary formation

Shale, sh; *shale containing limestone concretions,* shl; *bentonite bed (brown waxy claystone, 0.5–2.5 inches thick),* bt; *interbedded shale and sandstone, also sandy shale,* shs; *claystone, massive and blocky, poorly fissile,* cl; *claystone containing limestone concretions,* cll; *sandy claystone or clayey sandstone, also interbedded sandstone and claystone when individual beds are less than 1 foot thick, also complexly mottled and interlensed beds of claystone and sandstone,* scl; *interbedded claystone and pebbly sandstone,* clp; *silty claystone or clayey siltstone, also interbedded siltstone and claystone when individual beds are less than 1 foot thick, also complexly mottled and interlensed beds of siltstone and claystone,* cst; *siltstone,* st; *sandy siltstone or silty sandstone, also interbedded sandstone and siltstone when individual beds are less than 1 foot thick, also complexly mottled and interlensed beds of sandstone and siltstone,* sst; *interbedded siltstone and pebbly sandstone, also pebbly sandstone mottled with irregular lenses of siltstone,* stp; *sandstone,* ss; *pebbly sandstone,* pss

Contact

Fault
Direction of relative movement unknown

Fault
Arrows show apparent direction of relative movement

Schroeckingerite deposit

DS-52-166; (6.0); .009; .014
DS-52-167; (7.6); .012; .021

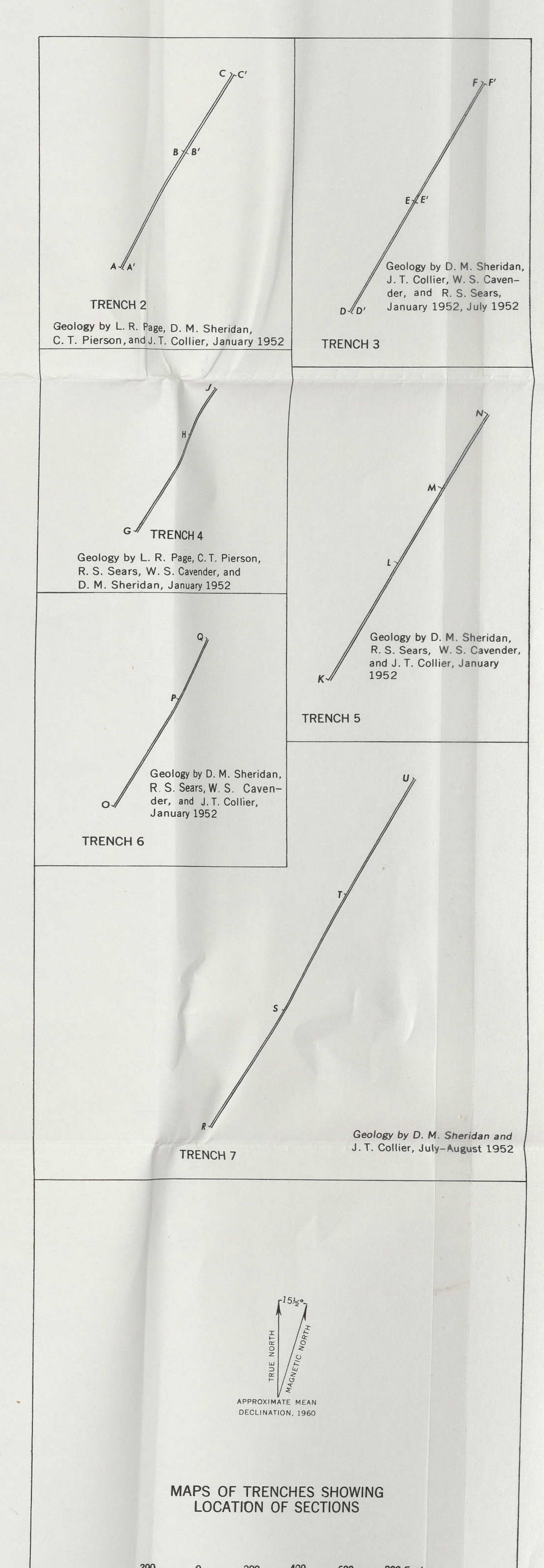
Face-cut samples in schroeckingerite deposit
Number of sample; (area of sample in square feet); percent equivalent uranium; percent uranium

DS-H-408; 10.0; .003; <.001

Horizontal channel sample
Number of sample, length of sample in feet, percent equivalent uranium, percent uranium

Water level in trench

FL-1
Fossil locality



MAPS OF TRENCHES SHOWING LOCATION OF SECTIONS

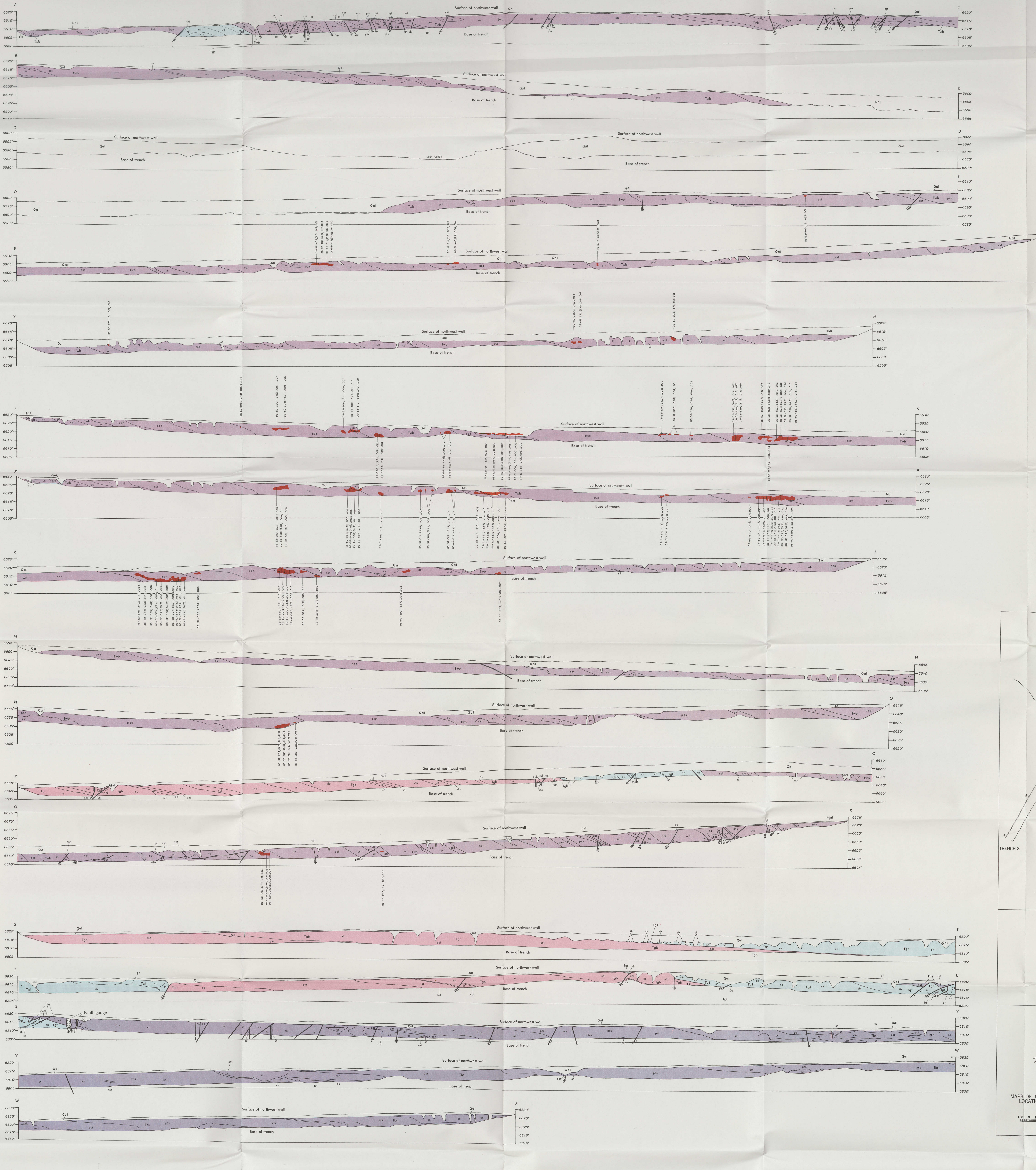
INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.—1962 10035

GEOLOGIC SECTIONS OF TRENCHES 2–7, LOST CREEK SCHROECKINGERITE DEPOSITS, SWEETWATER COUNTY, WYOMING

Scale 1:240

20 0 20 40 60 80 100 Feet

Datum is approximate mean sea level



EXPLANATION

QUATERNARY — *Pleistocene(?) and Recent*

Qal — Overburden
Alluvium, colluvium, and terrace deposits

UNCONFORMITY

TERTIARY — *Eocene*

Twb — Cathedral Bluffs tongue of Wasatch formation and Battle Spring formation, undifferentiated

Tbs — Battle Spring formation

Tgt — Tipton tongue of Green River formation

Tgb — Tipton tongue of Green River formation and Battle Spring formation, undifferentiated

LITHOLOGIC UNITS

Letter symbols used to designate lithologic units within a Tertiary formation

Shale, sh*; shale containing limestone concretions,* shl*; bentonite bed (brown waxy claystone, 0.5–3.0 inches thick),* bt*; interbedded shale and sandstone, also sandy shale,* shs*; claystone, massive and blocky, poorly fissile,* cl*; claystone containing limestone concretions,* cll*; sandy claystone or clayey sandstone, also interbedded sandstone and claystone when individual beds are less than 1 foot thick, also complexly mottled and interlensed beds of claystone and sandstone,* scl*; interbedded claystone and pebbly sandstone,* cl*; silty claystone or clayey siltstone, also interbedded siltstone and claystone when individual beds are less than 1 foot thick, also complexly mottled and interlensed beds of siltstone and claystone,* cst*; siltstone,* st*; sandy siltstone or silty sandstone, also interbedded sandstone and siltstone when individual beds are less than 1 foot thick, also complexly mottled and interlensed beds of sandstone and siltstone,* sst*; interbedded siltstone and pebbly sandstone, also pebbly sandstone mottled with irregular lenses of siltstone,* stp*, sandstone,* ss*; pebbly sandstone,* pss

Contact

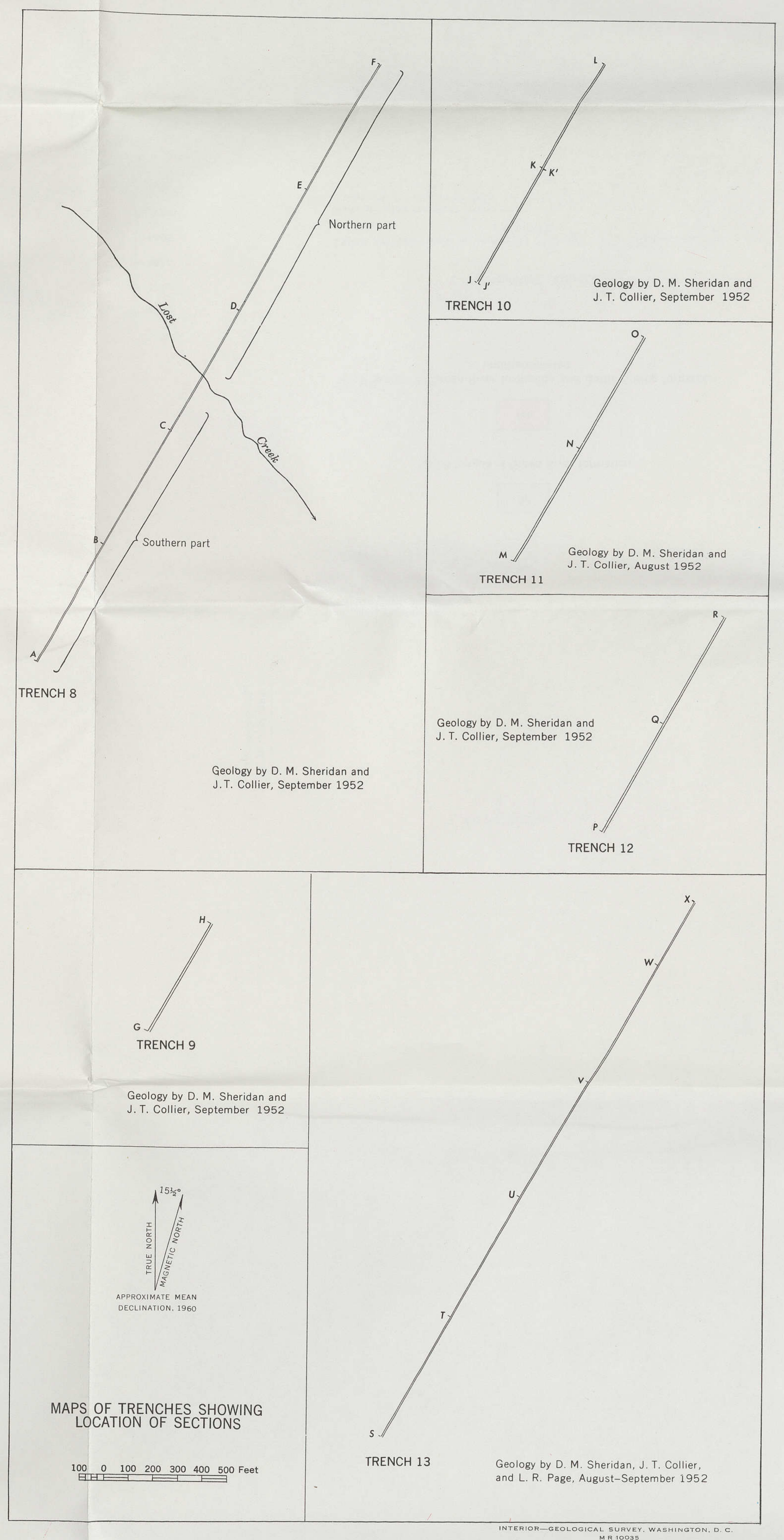
Fault
Direction of relative movement unknown

Fault
Dashed where approximately located; arrows show apparent direction of relative movement

Schroeckingerite deposit

DS-52-317; (3.2); .012; .014 DS-52-318; (4.3); .012; .014
Face-cut samples in schroeckingerite deposit
Number of sample; (area of sample in square feet); percent equivalent uranium; percent uranium

Water level in trench



MAPS OF TRENCHES SHOWING LOCATION OF SECTIONS

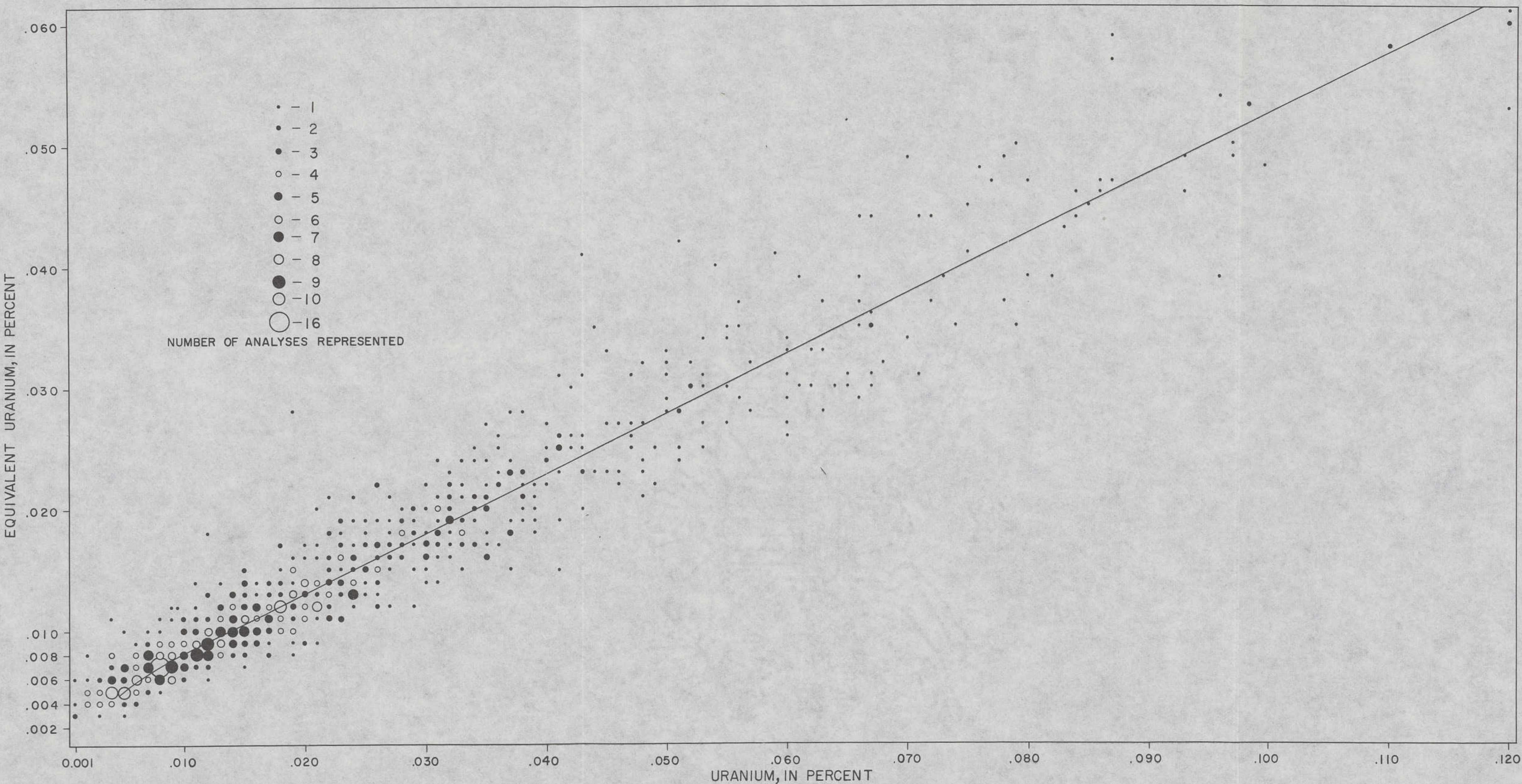
INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.
M R 10035

GEOLOGIC SECTIONS OF TRENCHES 8–13, LOST CREEK SCHROECKINGERITE DEPOSITS, SWEETWATER COUNTY, WYOMING

Scale 1:240

20 0 20 40 60 80 100 Feet

Datum is approximate mean sea level



GRAPH SHOWING RELATION OF EQUIVALENT URANIUM TO URANIUM IN THE LOST CREEK SCHROECKINGERITE DEPOSITS. ANALYSES OF 820 SAMPLES FROM TRENCHES