Uranium Resources of the Cedar Mountain Area Emery County, Utah A Regional Synthesis

By HENRY S. JOHNSON, Jr.

CONTRIBUTIONS TO THE GEOLOGY OF URANIUM

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CONTRIBUTIONS TO THE GEOLOGY OF URANIUM

URANIUM RESOURCES OF THE CEDAR MOUNTAIN AREA EMERY COUNTY, UTAH, A REGIONAL SYNTHESIS

By HENRY S. JOHNSON, JR.

ABSTRACT

The results of field reconnaissance and office study of available data pertaining to the Cedar Mountain area, Emery County, Utah, are presented in this report, which is part of a series of reports synthesizing the geologic relations of uranium deposits in all stratigraphic units on the Colorado Plateau. Results suggest that the Chinle and Morrison formations and possibly the Cedar Mountain formation have further potential for sandstone-type uranium deposits in the area. Appraisals of unexposed units are based on the premise that primary sedimentary features are the major control of favorable ground, and geology and data on frequency of ore deposits are in part extrapolated from the San Rafael Swell to the Cedar Mountain area. If tectonic structural features such as the San Rafael Swell should be the major control, the uranium ore potential of the Cedar Mountain area may be considerably less than is suggested herein.

The Monitor Butte member of the Chinle formation is considered generally favorable for uranium deposits in a broad northwestward-trending belt paralleling the line of pinchout of this member in the southern third of the Cedar Mountain area. Sandstone lenses approaching the thickness (as much as 30 feet thick) of the lens at the Delta mine in the neighboring San Rafael Swell may contain ore deposits as large as 100,000 tons in size. Depths to this unit are everywhere greater than 1,000 feet.

The Moss Back member of the Chinle formation is thought to be generally favorable for uranium deposits over most of the southern third of the Cedar Mountain area. In this member, channels or wide, shallow channel systems, such as that passing through Temple Mountain and Green Vein Mesa in the San Rafael Swell, are thought to be favorable for uranium deposits 10,000 to 100,000 tons in size. Depths to this unit are also greater than 1,000 feet within the Cedar Mountain area.

The Salt Wash member of the Morrison formation has been the source of about 90 percent of all uranium ore mined in the Cedar Mountain area but has not been found to contain deposits larger than a few hundred tons in size. This unit is thought to be generally unfavorable for uranium deposits in this area except in a belt coinciding with a lobe of thicker Salt Wash trending northwestward through T. 20 S., R. 9 E., Salt Lake meridian. This lobe of thicker Salt Wash is interpreted as representing a trunk channel system on the depositional fan formed by the Salt Wash member.

Minor uranium occurrences also are known in the Brushy Basin member of the Morrison formation and in the upper shale member of the Cedar Mountain formation in the Cedar Mountain area. Uranium in these deposits is associated with carbonaceous material in siltstone or claystone, and ore grades are commonly submarginal. These units may, however, contain fairly large tonnages of low-grade uranium-bearing rock.

INTRODUCTION

PURPOSE AND SCOPE OF REPORT

The purpose of this report is to present the results of geologic reconnaissance and office studies of available data pertaining to the uranium resources of the Cedar Mountain area, Emery County, Utah (fig. 3). The report is part of a series of similar reports synthesizing the geologic relations of uranium deposits in all stratigraphic units on the Colorado Plateau. The history, general geology, and uranium occurrences of the area are briefly reviewed, and an attempt is made to appraise the relative favorability of potentially ore-bearing geologic units for significant uranium deposits. Expected deposit size, depth to ore, ore controls, and major controls of favorable ground are also discussed.

Fieldwork was done during the summer of 1955 as part of regional reconnaissance geologic studies of uranium resources of all geologic units on the Colorado Plateau. The work was carried out by the U.S. Geological Survey on behalf of the Division of Raw Materials of the U.S. Atomic Energy Commission.

DATA SOURCES AND METHODS OF STUDY

Data used in this study include production records maintained by the Grand Junction Operations Office of the U.S. Atomic Energy Commission, reserve estimates and geologic observations made by the writer during reconnaissance visits to the Cedar Mountain area, stratigraphic sections measured by geologists of the U.S. Geological Survey's Colorado Plateau project, and the accumulated data contained in published reports and numerous written communications from members of the U.S. Atomic Energy Commission and U.S. Geological Survey.

Fieldwork consisted of visits to most of the known uranium deposits in the area and reconnaissance along the outcrop of potentially ore-bearing formations. At each deposit an attempt was made to determine the stratigraphic position of the ore-bearing unit; lithologic, stratigraphic, and structural controls affecting the deposit; indicated and inferred reserves and the size range of the deposit; ore trends and guides; ore potential in the immediate deposit area; and the desirability of further exploration in the deposit area.

Office work consisted principally of compilation of production data from records of the U.S. Atomic Energy Commission, preparing estimates of indicated and inferred reserves for each deposit and for the area as a whole, and calculating the uranium ore potential for the whole Cedar Mountain area.

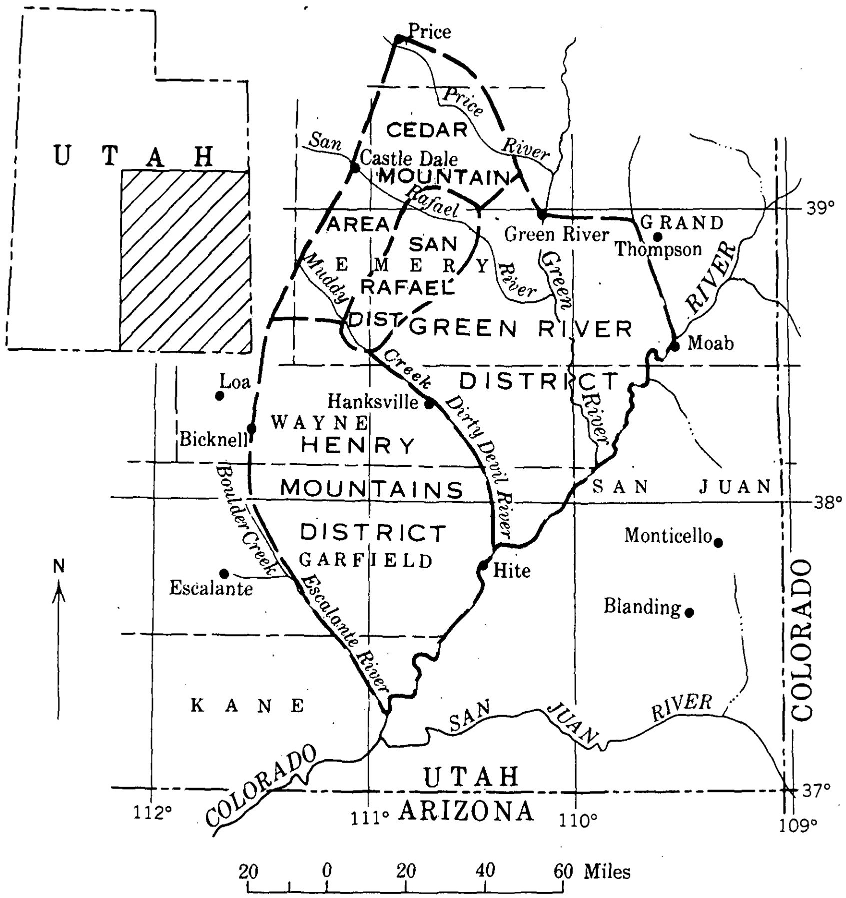

FIGURE 3.—Index map of Utah showing location of Cedar Mountain area and adjacent districts.

GEOGRAPHY OF THE AREA

The Cedar Mountain area is in Emery County, Utah, and extends slightly into Carbon County to the north and Sevier County to the southwest. In this report the Cedar Mountain area is considered to be north and west of the contact between the Navajo sandstone and the Carmel formation on the north and west sides of the San Rafael Swell, north of a line extending west from the intersection of the Muddy River with the San Rafael Swell to the junction of Utah Highway 72 with Last Chance Creek, east of Utah Highways 72 and 10, and south of U.S. Highway 50 between Price and Green River (fig. 3). The area is served by U.S. Highway 50 and Utah Highway 10 and contains the towns of Price, Huntington, Castle Dale, Ferron, Emery, and several smaller communities.

The Cedar Mountain area is bounded on the east by the uneven dip slope made by the outcrop of the Navajo sandstone on the northern end and west flank of the San Rafael Swell. North and west of the San Rafael Swell, westward-dipping intermixed soft and hard rocks of the Carmel, Entrada, Curtis, Summerville, Morrison, Cedar Mountain, Dakota, and Mancos formations form badlands, dip slopes, and cliffs. Along the western edge of the area, pediment surfaces are common. They extend from the base of steep clifflike slopes developed in the Mancos and Mesaverde formations to a short distance further west.

The climate is semiarid with very hot summers and cold winters. Vegetation is very sparse over most of the area; and during the short periods of rainfall, flash floods are common. Water, fuel, labor, and mining supplies are available in the towns along the western edges of the area.

HISTORY OF MINING IN THE CEDAR MOUNTAIN AREA

Prior to 1954, no uranium ore was produced from the Cedar Mountain area. In December 1943 and January 1944, Union Mines Development Corporation geologists studied 12 miles of outcrop of the Salt Wash member of the Morrison formation in the vicinity of Helium Dome (Woodside anticline, fig. 5) in the northeastern part of the area but found no uranium or vanadium deposits (R. K. Kirkpatrick, written communication, 1944). These Union Mines Development Corporation geologists did not continue their reconnaissance west of Helium Dome because they found the Salt Wash was thinner and more argillaceous in that direction.

In 1951, a small amount of low-grade uranium ore was produced from the South Rim mine about 14 miles east of Castle Dale, Utah. U.S. Atomic Energy Commission geologists carried on intermittent reconnaissance of the Cedar Mountain area during 1953 and 1954; and early in 1954, a small shipment of uranium ore was made from the Cedar Ridge claims about 9 miles east of Cleveland, Utah. Since then, small intermittent production has come from the Cottonwood No. 1 claim on the northwest side of Cedar Mountain (fig. 8) and from the White Star group near Molen Seep Wash about 10 miles east of Ferron, Utah.

GEOLOGIC SETTING

The geology of the Cedar Mountain area, or parts of it, has been discussed by Lupton (1916), Clark (1928), Gilluly (1929), Spieker (1931), Stokes (1944 and 1952), and Katich (1954). The rocks exposed within the area range in age from Jurassic to Cretaceous and consist of a total of about 5,000 to 6,000 feet of limestone, shale, shaly sandstone, mudstone, sandstone, and conglomerate (table 1). Not exposed, but underlying the area and of potential economic interest, is about 1,500 feet of sandstone, siltstone, and mudstone of Triassic and Jurassic age. Rocks older than Triassic are not known to contain uranium deposits in or adjacent to the Cedar Mountain area and indeed are so inaccessible as to be almost impossible to evaluate as host rocks for ore. For these reasons they are arbitrarily considered to have little or no potential for economic uranium deposits in the Cedar Mountain area and are therefore not discussed. Igneous rocks are confined to dikes and sills of probable Tertiary age in the southern part of the area. The general structure over the whole area is monoclinal with gentle westerly dips.

STRATIGRAPHY

The Chinle, Wingate, Kayenta, and Navajo formations do not crop out in the Cedar Mountain area (except for thin fault slivers of Navajo) but are thought to be present at fairly shallow depths. These units are described from exposures in the San Rafael Swell, and their probable characteristics in the Cedar Mountain area are discussed. These unexposed units are included herein because they may contain potential uranium resources.

The Carmel formation of Jurassic age and younger units crop out in the Cedar Mountain area and may be described and evaluated from exposures.

CHINLE FORMATION

The Chinle formation of Late Triassic age is the oldest formation discussed in this report. It is described in some detail because it may be uranium bearing at depth in the Cedar Mountain area. The Chinle crops out in the adjacent San Rafael Swell and there can be divided into four members. The basal member has recently been defined and named the Temple Mountain member by Robeck (1956). Above this in ascending order are three members thought to correlate with the Monitor Butte member, recognized by I. J. Witkind and R. E. Thaden (written communication) in Monument Valley, Ariz.; the Moss Back member, recognized by Stewart (1957) in White Canyon, Utah; and the Church Rock member, also recognized by Witkind and Thaden in Monument Valley. In earlier reports on the San Rafael Swell (Gilluly and Reeside, 1928; Gilluly, 1929), the Temple Mountain, Monitor Butte, and Moss Back members were included in the Shinarump conglomerate which is now the Shinarump member of the Chinle formation.

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TABLE 1.—*Generalized section of rock formations in the Cedar Mountain area, Emery County, Utah*

[Exposed rocks range in age from Jurassic to Cretaceous; unexposed rocks range in age from Triassic to Jurassic (Navajo sandstone). In part after Spieker (1931), Stokes (1952), Hunt (1953), and Katich (1954)]

System	Series	Group	Formation	Member	Thickness (feet)	Description
Cretaceous	Upper Cretaceous		Mancos shale	Masuk	300–1, 000	Blue-black to gray sandy shale; marine.
				Emery sandstone	50–800	Massive to thin-bedded sandstone; forms steplike cliffs.
				Blue Gate shale	1, 500–2, 400	Bluish-gray marine shale.
				Ferron sandstone	100–675	Buff, brown, and white coal-bearing sandstone.
				Tununk shale	400–650	Bluish-gray marine shale.
	Lower(?) and upper Cretaceous		Dakota sandstone		0–50	Light-gray to yellowish-brown crossbedded sandstone and conglomerate.
			Unconformity			
	Lower Cretaceous		Cedar Mountain formation	Upper shale	100–400	Drab to varicolored, generally gray, green, or purplish red shale and mudstone, with minor lenses of sandstone. "Gastrolith" bearing.

			Lower conglomerate	0–50	Conglomerate with minor sandstone lenses; black and varicolored chert pebbles.
		Unconformity			
Jurassic	Upper Jurassic	Morrison formation	Brushy Basin shale	100–400	Variegated purple, red, green, and gray mudstone; minor sandstone and conglomerate lenses.
Jurassic	Upper Jurassic	Morrison formation	Salt Wash sandstone	10–200	Grayish-white to light-yellow-brown lenticular crossbedded sandstone; interbedded gray-green and red-brown mudstone.
		Unconformity			
Jurassic	Upper Jurassic	San Rafael group: Summerville formation		100–200	Thin evenly bedded earthy red-brown sandstone and shale; gypsum beds at top.
Jurassic	Upper Jurassic	San Rafael group: Curtis formation		160–250	Evenly bedded greenish-gray sandstone and siltstone; glauconitic.
		Unconformity			
Jurassic	Upper Jurassic	San Rafael group: Entrada sandstone		260–840	Thin- to thick-bedded earthy red-brown sandstone.
Jurassic	Upper and Middle Jurassic	San Rafael group: Carmel formation		150–650	Limestone, red and green shale, thin buff and red sandstone, and thick beds of gypsum near the top.
		Unconformity			

TABLE 1.—*Generalized section of rock formations in the Cedar Mountain area, Emery County, Utah*—Continued

System	Series	Group	Formation	Member	Thickness (feet)	Description
Jurassic—Continued	Upper and Middle Jurassic—Con.	Glen Canyon group	Navajo sandstone		400–700	Tan to light-gray massive crossbedded sandstone.
Jurassic(?)	Lower Jurassic(?)		Kayenta formation		50–300	Thin-bedded red sandstone and shaly sandstone with minor amounts of red and green mudstone; irregularly interfingering and channeling.
			Wingate sandstone		350–400	Light-red to buff massive crossbedded sandstone; cliffmaker.
			Unconformity			
	Upper Triassic		Chinle formation	Church Rock	130–200	Light-reddish-brown sandstone and siltstone.
				Moss Back	0–170	Light-greenish-gray to yellowish-gray sandstone and conglomeratic sandstone.

Triassic			Monitor Butte	0–100	Purplish-red siltstone to greenish-gray sandstone.
			Temple Mountain	0–100	Light-gray to buff conglomeratic sandstone and green to purple or red-brown siltstone; dark-gray carbonaceous shale in places.
		Unconformity			
	Lower and Middle(?) Triassic	Moenkopi formation		700–850	Red to gray micaceous ripple-marked sandstone and siltstone.

TEMPLE MOUNTAIN MEMBER

The Temple Mountain member of the Chinle formation is the oldest unit with which this report is concerned. It does not crop out within the Cedar Mountain area but is exposed to the southeast in the San Rafael Swell, where it contains small low-grade uranium deposits at several places. In the San Rafael Swell this unit overlies siltstone and fine-grained sandstone of the Moenkopi formation and was deposited as a thin blanket of mudstone, siltstone, and sandstone by northwestward-flowing streams. Because of a distinctive purple, red, brown, and white mottled color phenomenon associated with this unit in many places, it is sometimes referred to as the purple-white zone. Relief on top of the Moenkopi is low, and channels cut in this surface and filled with sediments of the Temple Mountain member are generally broad and shallow with only a few feet of scour. The two principal types of deposition of the Temple Mountain member are channel-fill and nonchannel deposits.

Channel-fill deposits of the Temple Mountain member contain mudstone, siltstone, and lenses as much as 30 feet thick of light-gray to buff sandstone and conglomeratic sandstone with subordinate interbedded mudstone and sparse to abundant carbonaceous material in the form of small stems, leaf imprints, and seams of coalified wood. Pebbles in the conglomeratic sandstone are clear to milky or pink quartz. In some places carbonaceous material is very abundant, and the rock is a dark-gray carbonaceous shale or thin-bedded sandstone with carbon films along bedding planes.

Nonchannel deposits of the Temple Mountain member, probably flood-plain deposits or material laid down by sheet wash over a nearly flat surface, consist largely of mudstone and siltstone with a sparse amount of fine- to coarse-grained clear subrounded quartz scattered through the rock. Much of this is very difficult to separate from the underlying Moenkopi formation and is probably largely reworked Moenkopi.

Because the source of coarse sediments in the Temple Mountain member was to the east of the San Rafael Swell and because Temple Mountain streams flowed westward, rocks of the Temple Mountain member may be expected to be even finer grained and to contain smaller sandstone lenses under the Cedar Mountain area than where exposed in the San Rafael Swell.

MONITOR BUTTE MEMBER

The Monitor Butte member (written *communication*, I. J. Witkind and R. E. Thaden) of the Chinle formation underlies the southern part of the Cedar Mountain area and pinches out along a projected northwestward-trending line passing a little south of the town of Ferron (fig. 6). This unit is composed of purplish-red siltstone and mudstone and lenses of greenish-gray to buff sandstone where exposed to the east in the San Rafael Swell. It has a maximum thickness of about 100 feet in the southernmost part of the Cedar Mountain area and wedges out to the north. Significant uranium deposits occur in the Monitor Butte member in the San Rafael Swell, and the unit may be uranium bearing at depth in the Cedar Mountain area.

MOSS BACK MEMBER

The Moss Back member (Stewart, 1957) of the Chinle formation does not crop out within the Cedar Mountain area but is present at depths greater than 1,000 feet under most of the area south of a projected northwestward-trending line of pinchout passing approximately halfway between Price and Castle Dale (fig. 7). The unit is composed of interfingering lenses of mudstone, sandstone, and conglomerate and was apparently deposited as a long, narrow fan by northwestward-flowing streams. North of the Monitor Butte pinchout, the Moss Back lies on the Temple Mountain member of the Chinle formation or possibly, in some places, directly on the Moenkopi. The Moss Back is also thought to pinch out along a northwestward-trending line near the southern boundary of the Cedar Mountain area. There the Moss Back is underlain by 100 feet or so of the Monitor Butte member of the Chinle formation. The Moss Back contains significant uranium deposits where it is exposed in the San Rafael Swell and may be uranium bearing at depth in the Cedar Mountain area.

CHURCH ROCK MEMBER

The Church Rock member (I. J. Witkind and R. E. Thaden, written communication) of the Chinle formation is also present at depth in the Cedar Mountain area. Where exposed in the San Rafael Swell, this unit is composed of light-reddish-brown sandstone and siltstone and contains a few minor occurrences of uranium.

WINGATE SANDSTONE AND KAYENTA FORMATION

The Wingate sandstone of Late Triassic age and the Kayenta formation of Early Jurassic(?) age do not crop out in the Cedar Mountain area but are present at depth. Where these formations are exposed in the San Rafael Swell, they are composed of light-red to buff massive crossbedded sandstone and thin-bedded red sandstone and shaly sandstone. They do not contain uranium deposits except for small occurrences in the Wingate in zones of fracturing associated with the Temple Mountain collapse structure. The lithology of these units is expected to be essentially the same beneath the Cedar Mountain area.

NAVAJO SANDSTONE

The Navajo sandstone of Jurassic and Jurassic(?) age is present at depth in the Cedar Mountain area and crops out only in a few small slivers in fault zones in T. 19 S., R. 13 E., Salt Lake meridian, east of Cedar Mountain (fig. 8). The Navajo is composed of tan to light-gray massive crossbedded sandstone. It contains only minor uranium and copper occurrences in the San Rafael Swell and is probably not a significant uranium bearer in the Cedar Mountain area.

CARMEL FORMATION

The Carmel formation of Late and Middle Jurassic age overlies the Navajo sandstone and is the oldest unit exposed at the surface in the Cedar Mountain area, except for small fault slivers of Navajo sandstone. This formation is composed of very resistant limestone and limy sandstone in the lower part and becomes more shaly and more gypsiferous upward. The lower part of the Carmel forms dip slopes on the western flank of the San Rafael Swell; and the less resistant shaly and gypsiferous upper part forms a wide strike valley, the surface of which is dissected into typical badlands. No uranium deposits are known in this unit in the Cedar Mountain area.

ENTRADA SANDSTONE

Overlying the Carmel formation is the Entrada sandstone of Late Jurassic age. The Entrada is composed of thin- to thick-bedded red-brown earthy sandstone and forms a cliff at the west margin of the strike valley formed in the Carmel formation. It is in part the result of wind deposition and in part the result of deposition by water (Stokes and Holmes, 1954). Fossils are apparently absent, and carbonaceous material is very rare but does occur in a few very thin seams. Minor uranium occurrences are known in the Entrada in the Cedar Mountain area.

CURTIS FORMATION

The Curtis formation of Late Jurassic age is composed of greenish-gray glauconitic sandstone and siltstone and overlies the Entrada sandstone with unconformable contact. In some places slight angularity is evident. The formation forms cliffs with the Entrada. No uranium deposits are known to occur in this unit in the Cedar Mountain area.

SUMMERVILLE FORMATION

Conformably overlying the Curtis formation is the Summerville formation of Late Jurassic age. The Summerville is composed of thin-bedded red-brown sandstone and shale, with interbedded gypsum near the top of the unit, and forms cliffs and steep slopes beneath the overlying Morrison formation. Weak radioactivity has been reported from the Summerville, but no significant ore deposits have been found.

MORRISON FORMATION

Unconformably overlying the Summerville formation is the Morrison formation of Late Jurassic age. In the Cedar Mountain area the Morrison is represented by the Salt Wash and Brushy Basin members, both of which are uranium bearing.

SALT WASH MEMBER

The Salt Wash member of the Morrison formation is composed of grayish-white to light-yellow-brown fluviatile sandstone lenses with interbedded gray- green and reddish-brown mudstone. Carbonized leaves, stems, and logs are abundant in some of the sandstones. In the Cedar Mountain area the Salt Wash ranges in thickness from 10 to 200 feet and grades from a sandstone-mudstone facies to a predominantly mudstone facies farther west and north. Figure 4 is an isopach map showing a lobe of thicker Salt Wash extending out to the northwest in T. 20 S., R. 9 E., Salt Lake meridian. The thicker Salt Wash in this lobe is accompanied by an increased average thickness of individual fluviatile sandstone lenses and probably represents a trunk channel system or major drainage area on the fan of the Salt Wash. In the Cedar Mountain area individual sandstone lenses in the Salt Wash are generally less than 20 feet thick outside this trunk channel system and may be as thick as 30 to 40 feet within it.

BRUSHY BASIN MEMBER

The Brushy Basin member of the Morrison formation is composed of variegated purple, red, green, and gray mudstone with minor sandstone and conglomerate lenses and ranges in thickness from 100 to 400 feet in the Cedar Mountain area. The sandstone and conglomerate lenses may reach thicknesses of 20–30 feet but are in general discontinuous and completely surrounded by mudstone. The mudstone commonly contains appreciable amounts of bentonitic clay (Stokes, 1944), and carbonaceous material is rare.

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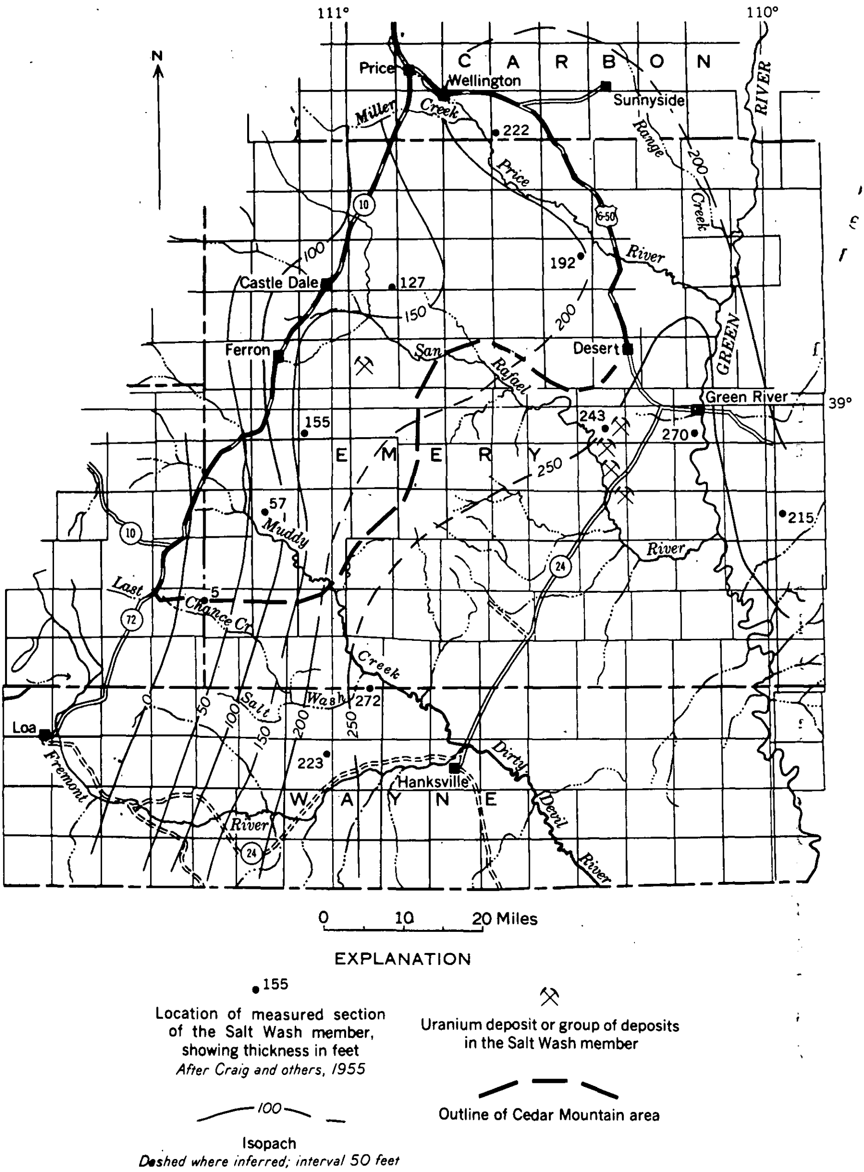


FIGURE 4.—Isopach map of Salt Wash member of the Morrison formation in part of eastern Utah.

CEDAR MOUNTAIN FORMATION

The Cedar Mountain formation of Late Cretaceous age is composed of a lower conglomerate member and an upper shale member which is very similar to the Brushy basin member of the Morrison formation.

LOWER CONGLOMERATE MEMBER

The lower conglomerate member unconformably overlies the Brushy Basin and is a blanketlike conglomerate layer as much as 50 feet thick over large parts of the Cedar Mountain area. This unit is composed principally of dark-colored chert pebbles with subordinate quartzite pebbles. Carbonaceous material is rare in the lower conglomerate member, and the unit is not uranium bearing to the writer's knowledge. Stokes (1950) has suggested that his Buckhorn conglomerate member or the lower conglomerate member may have been formed by a process of pedimentation.

UPPER SHALE MEMBER

The upper shale member of the Cedar Mountain formation is dominantly drab to variegated gray, green, or purplish-red shale and mudstone. Elongate northeastward-trending sandstone lenses, probably channel fills, are fairly numerous in this unit and weather out as low winding ridges as much as a mile in length (Stokes, 1944). Minor uranium occurrences associated with carbonaceous material have been found at several places in the upper shale member in the Cedar Mountain area.

DAKOTA SANDSTONE

Unconformably overlying the Cedar Mountain formation is the Dakota sandstone of Late(?) and Early Cretaceous age. This unit is composed of light-gray to yellowish-brown sandstone, conglomerate, and intermixed mudstone, carbonaceous shale, and in some places thin coal seams. The Dakota is as much as 50 feet thick in parts of the Cedar Mountain area but more commonly is absent. Uranium deposits of significant size have not been found in this formation in the Cedar Mountain area.

MANCOS SHALE

Conformably overlying the Dakota sandstone is the Mancos shale of Late Cretaceous age. This formation is several thousand feet thick and is predominantly dark-gray marine shale with two cliff-forming sandstones, the Ferron and Emery sandstone members. The shale members do not contain anomalous radioactivity, but the sandstones do in some places in association with carbonized wood fragments or coaly material.

IGNEOUS ROCKS

Just south of the Cedar Mountain area, basalt flows and dikes are reported by Lupton (1916). Gilluly (1929) has described analcite-biotite diabase dikes and sills that crop out in the southern part of the San Rafael Swell and in the southern part of the Cedar Mountain area. These are the only igneous rocks in the Cedar Mountain area. They cut geologic units as young as the Morrison formation and are, therefore, post-Morrison in age. Reconnaissance of these dikes and sills by U.S. Geological Survey (R. C. Robeck, oral communication, 1955) and U.S. Atomic Energy Commission geologists (R. K. Pitman and H. N. Jensen, written communication, 1951) found little or no anomalous radioactivity. On the other hand, W. Scott Keys (written communication, 1954), of the U.S. Atomic Energy Commission, reports radiometric assays of dike rock indicating as much as 0.006 percent equivalent U_3O_8. Keys further states that many of the dikes can be detected from the air with scintillation equipment and give as much as twice background count on the ground. This weak radioactivity may, however, be all or in part due to elements other than uranium, and as yet there is no proof of a genetic relationship between these igneous rocks and uranium deposits in the sedimentary rocks.

STRUCTURE

The structure of the Cedar Mountain area is monoclinal and very simple (Lupton, 1916). In general the beds dip gently westward on the broad western flank of the San Rafael Swell with several small local domes superimposed on the regional structure (fig. 5). Several small subsidiary anticlines or domes occur on the northern nose of the San Rafael Swell. These are Woodside anticline, Chimney Rock anticline, and Farnham anticline (Kelley, 1955). The local structural features on the western edge of the Cedar Mountain area are the Castle Dale anticline about 3 miles east of Castle Dale; the Paradise dome in T. 20 S., R. 8 E., Salt Lake meridian; and the Rochester anticline (Lupton, 1916) in T. 21 S., R. 7 E., Salt Lake meridian. The principal effect of the monoclinal structure on the ore-bearing units is to cause them to be buried at progressively greater depths to the west.

The principal faults in the Cedar Mountain area are normal strike faults of relatively small displacement. Associated with the Farnham anticline are strike faults that are at either side of the fold and have displacements up to 300 feet. In T. 19 S., R. 13 E., Salt Lake meridian, there are several minor northward-trending faults which bring slivers of Navajo sandstone into contact with the overlying Carmel formation. On the west slope of Cedar Mountain (also known as the Red Plateau), there are several faults, the largest of which is traceable for 2–4 miles and has a displacement of 200–300 feet (Lupton, 1916). Other minor faults occur at the south

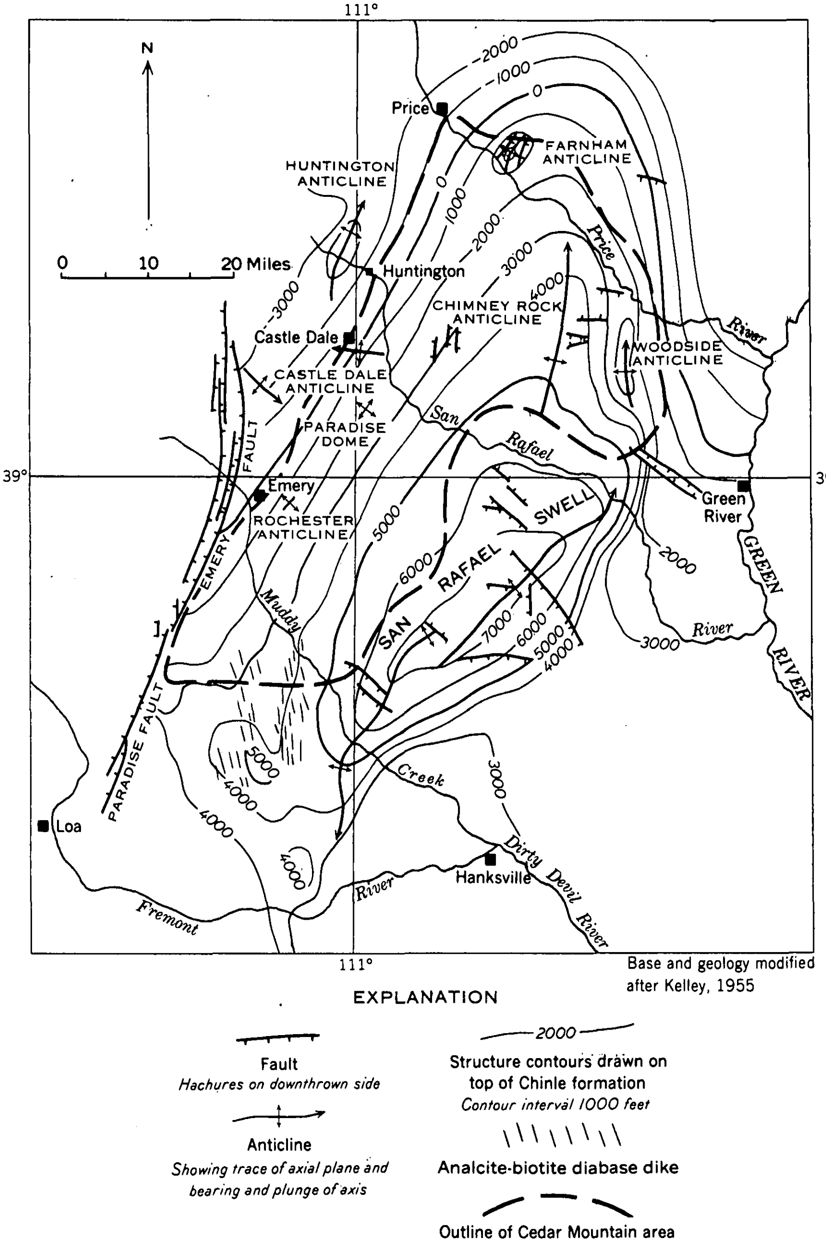


FIGURE 5.—Tectonic map of Cedar Mountain area and adjacent San Rafael Swell, Emery County, Utah.

end of Cedar Mountain. South of the town of Emery, the western edge of the Cedar Mountain area is essentially bounded by the northward-trending Emery and Paradise faults. These are normal faults with the west side displaced downward as much as 2,000 feet. Sandstone-type uranium deposits in the Cedar Mountain area do not seem to be genetically associated with faults.

ORE DEPOSITS

Uranium in anomalous amounts is known to occur in the Entrada, Summerville, Morrison, and Cedar Mountain formations in the Cedar Mountain area. The Chinle, Wingate, and Navajo formations are not exposed in the Cedar Mountain area but underlie it and are possibly uranium bearing. The ore deposits are either bedded deposits associated with carbonaceous material, or they are fracture-controlled occurrences of secondary minerals. No uranium deposits have been found in association with igneous rocks in the Cedar Mountain area.

MODE OF OCCURRENCE

Sandstone-type uranium deposits in the Cedar Mountain area are similar to those elsewhere on the Colorado Plateau. Finch (1955) has given a good general description of these. Uranium, generally accompanied by greater or lesser amounts of vanadium and (or) copper, occurs in fairly well-defined tabular elongate ore deposits for the most part parallel to bedding in the host rock and oriented parallel to sedimentary trends. Carbonaceous material is commonly present and probably has played an important part in the precipitation of the ore minerals.

Ore deposits in the Chinle formation in the neighboring San Rafael Swell range from about 1 to 20 feet in thickness, and most of the ore is in deposits larger than 100,000 tons in size and has an average thickness of about 5 feet (Johnson, 1957). (Clusters of small- to medium-sized ore bodies with intervening mineralized ground are considered as one ore deposit.) In general, the larger deposits tend to have a greater average thickness than smaller deposits. This implies that deposits of large tonnage do not necessarily present proportionally wider targets for exploration than deposits of less tonnage.

The average thickness of deposits in the Morrison and Cedar Mountain formations in the Cedar Mountain area is about 2 feet. Deposits larger than 1,000 tons in size have yet to be found.

Deposits of uraniferous asphaltite with associated pyrite, galena, native arsenic, realgar, and arsenopyrite (?) are present in the Coconino, Kaibab, Moenkopi, Chinle, and Wingate formations at

Temple Mountain in the San Rafael Swell (Keys and White, 1956). These deposits are distinguishable from the bedded uranium deposits common to the Moss Back member of the Chinle formation in that area in that they have a considerable vertical range and are restricted to and controlled by roughly pipelike zones of fracturing, faulting, and brecciation.

Blue and green secondary copper minerals and spotty, weakly anomalous radioactivity occur in the Navajo sandstone at the Copper Globe mine in T. 23 S., R. 9 E., Salt Lake meridian, in the San Rafael district and in faulted ground in T. 19 S., R. 13 E., Salt Lake meridian, in the Cedar Mountain area. These deposits are in thick massive sandstones or thin brecciated limestone in areas of faulting, fracturing, and strong jointing.

Some uranium ore has been produced from the fracture controlled deposits at Temple Mountain, and small amounts of copper ore have come from the Copper Globe mine. Production from fracture-controlled deposits of this type has, however, accounted for only a small part of the total uranium ore produced in the San Rafael district, and no ore has come from deposits of this type in the Cedar Mountain area.

MINERALOGY

Uranium deposits in the Cedar Mountain area may be classed as vanadium-uranium deposits (vanadium content greater than uranium) or as uranium deposits with lesser amounts of copper or vanadium. Of the deposits now known, those in the Morrison and Cedar Mountain formations are roughly divided into vanadium-uranium deposits and uranium deposits with minor amounts of vanadium. The mineralized occurrences in the Entrada sandstone are uranium deposits with minor amounts of copper.

All the uranium deposits now known in the Cedar Mountain area are oxidized; and the principal uranium minerals are carnotite, tyuyamunite, and other uranium vanadates. In deposits with abundant vanadium, the chief vanadium minerals may be vanadium-bearing hydrous micas or vanadium-bearing clay minerals. Those deposits containing copper have green and blue secondary copper minerals on the outcrop.

Ore deposits in rocks of Triassic age in the Cedar Mountain area, like ore deposits in these formations in the San Rafael Swell, may be expected to be unoxidized and will probably be composed largely of uraninite, pyrite, and minor amounts of chalcopyrite, galena, and sphalerite. Low-valent vanadium minerals may also be present in appreciable amounts in some of these deposits. Where coalified wood or hydrocarbons are abundant, uranium may be found in thucholite-like resins or asphaltites.

CONTROLS

In the Cedar Mountain area carbonaceous material, thick sandstone lenses, channels or channel systems, and stratigraphic pinch-outs seem to play some part in the localization of ore deposits. Empirical data indicate that these factors are important in the localization of ore throughout the Colorado Plateau. As far as the writer has been able to observe, igneous rocks and faults or fracture systems do not control the bedded ore deposits.

In some parts of the Colorado Plateau, salt structural features have apparently had an indirect influence on ore deposition in that these structures were mobile during Triassic and Jurassic time and influenced sedimentary features which later played a part in the localization of ore deposits. The domes, anticlines, and synclines of the Cedar Mountain area, however, are apparently not related to salt flowage and seem to have had no influence on ore deposition, even though in theory they should have controlled to some extent the passage of ore-bearing solutions through the rock regardless of the origin of these solutions.

Carbonaceous material in the form of carbonized wood fragments, leaves, or stems is present in all uranium deposits in the Cedar Mountain area and is commonly selectively replaced by uranium. According to R. M. Garrels and A. M. Pommer (1959), woody material has a high capability for precipitating uranium and vanadium from oxidizing solutions; less than 1.0 percent by weight of lignite is necessary to precipitate several percent of U_3O_8 and V_2O_5 in the average host rock. The general occurrence of nonmineralized as well as mineralized carbonaceous material throughout the ore-bearing units of the Cedar Mountain area suggests that the mere presence of carbonaceous material is not enough to cause precipitation of ore minerals. Where carbonaceous material is plentiful, other factors such as the transmissivity of the host rock may play a more important part in the localization of ore deposits. It is, however, commonly true that the larger uranium deposits are found in association with greater-than-average concentrations of carbonaceous material.

Relatively thick sandstone lenses, especially in the Salt Wash member of the Morrison formation, also seem to exert a control on localization of ore. Fieldwork in the Cedar Mountain area indicates that where individual sandstone lenses of the Salt Wash are less than 20 feet thick, ore deposits of any appreciable size are not to be expected. Where these sandstone lenses are 30–40 feet or more in thickness, several small but minable deposits have been found. Apparently, thicker relatively continuous sandstone lenses are considerably more conducive to the deposition of sizeable ore bodies than are thin or discontinuous lenses or blanketlike sandstone beds. This is in agreement with ideas expressed by Mullens and Freeman (1957). Thicker sandstone lenses are also relatively favorable in units other than the Salt Wash. Channeling at the base of an ore-bearing unit results in a thickening of the unit and so does a building up or sandpiling effect in the upper part of the unit. Both types of thickening have resulted in favorable loci for uranium deposition on the Colorado Plateau. It should be noted, however, that thickness alone is not necessarily favorable for uranium deposits. Thick massive blanketlike sandstones are unfavorable. Solutions passing through them probably tend to be dispersed rather than concentrated. It is the relatively thick sandstone lens surrounded by thinner or more discontinuous sandstone and mudstone that is required.

Channels at the base of an ore-bearing unit are generally recognized to be favorable for uranium deposits on the Colorado Plateau. Probably the local thickening of the unit in the channel and the coarse channel-fill sediments help make a better passageway for laterally moving ore-bearing solutions than nonchannel deposits provide. Then too the interfingering of sandstone and mudstone in channels provides traps for ore. Carbonaceous material is generally more abundant in channels also.

Channel system, as used in this report, refers to an area in which several channels intermingle and bifurcate in the manner of a large braided stream. The greater concentration of channel-fill deposits within the area of the channel system makes this ground generally more favorable for uranium deposits than ground outside the channel system.

Pinchouts of certain stratigraphic units also seem to provide areas or belts of ground relatively favorable to ore deposits. The reason for this is not clear, but the pinchout may constitute a regional stratigraphic trap. Units that are predominantly sandstone are less blanketlike in the vicinity of pinchouts and may, therefore, contain more sedimentary traps and favorable host rocks in those areas. It should be remembered that these pinchouts are broad controls on favorable ground and not on individual deposits.

GUIDES TO ORE

In the Cedar Mountain area thick sandstone lenses (more than 20 feet thick) and the presence of carbonaceous material may be used as guides to ore in the Morrison formation. On or near outcrops, limonite in the sandstone is also a good guide. Where the ore-bearing unit is brown or reddish, a gray-green bleaching is to be expected in the vicinity of ore. Deposits in the Entrada sandstone are conspicuous because of this bleaching and commonly show blue and green secondary copper minerals at the outcrop. In deeply buried deposits in Triassic rocks, the presence of abundant pyrite or chalcopyrite is a good guide to ore. Channels or channel systems are also good guides to ore or favorable ground in units of Triassic and Jurassic age.

ORIGIN

The sources of the metals in Colorado Plateau uranium deposits are as yet not agreed upon. The metals may have been derived from detrital material, chemical precipitates, or volcanic ash within the sediments themselves; or they may have been supplied by hypogene solutions. The association of oil and uranium in parts of the San Rafael Swell and the occurrence of helium in quantity at Woodside anticline on the north end of the San Rafael Swell may suggest a possible genetic relationship between uranium deposits and uraniferous petroleum. Regardless of the sources of the metals, it is probable that they were brought to their present position in ore deposits by solutions which were similar to ground water and which moved for the most part laterally through the rocks until a trap or favorable host rock caused precipitation of the ore minerals.

Uranium in fracture-controlled ore deposits may have been derived from hypogene ore solutions or from solutions which obtained the uranium from primary bedded deposits. Ore in the collapse structure at Temple Mountain in the San Rafael Swell may be an example of a deposit formed by later hydrothermal solutions (probably from hot springs) that moved through fracture zones and altered and partly redistributed preexisting bedded ore bodies. Other geologists are about evenly divided in opinion as to whether uranium deposits in the collapse zone at Temple Mountain are hypogene or supergene in origin (Hess, 1922 and 1933; F. M. Murphy, written communiation, 1944; W. L. Stokes, written communication, 1947; D. G. Wyant, written communication, 1953; and Keys and White, 1956).

RELATIVE FAVORABILITY OF GROUND

All the potentially ore-bearing ground in the Cedar Mountain area is not equally favorable for uranium deposits. Knowledge of the geology of the area, the habits and probable controls of the ore deposits, and an understanding of what constitutes favorable host rocks and good passageways for the moving ore solutions enables one to attempt to predict the ground where significant ore deposits are most likely to occur. The following is a brief discussion of the relative favorability of each potentially ore-bearing unit within the Cedar Mountain area. Geology and ore potential of unexposed units are of necessity extrapolated from the San Rafael Swell, and the following arguments are based on the premise that primary sedimentary features are the major controls of ore deposits and favorable ground. If tectonic structural features such as the San Rafael Swell should be a major control, extrapolation from exposures in the Swell is not justified; and the uranium ore potential of the Cedar Mountain area may be considerably less than is suggested in this report.

PRE-CHINLE FORMATIONS

Bedded uranium deposits are not known in rocks older than the Chinle formation where these rocks are exposed in the San Rafael Swell. Similar lithologies and a consequent lack of bedded uranium deposits are probable in the adjacent Cedar Mountain area. Uranium-bearing asphaltite occurs with pyrite, galena, native arsenic, realgar, and arsenopyrite(?) in strongly fractured rocks of the Coconino, Kaibab, and Moenkopi formations in the Temple Mountain collapse structure in the San Rafael Swell (Keys and White, 1956); but no evidence of ore deposits of this type is found in the Cedar Mountain area. The depth to pre-Chinle formations is more than 1,500 feet everywhere in the Cedar Mountain area.

TEMPLE MOUNTAIN MEMBER OF THE CHINLE FORMATION

In the northern third of the San Rafael Swell, northwestward-trending channels are fairly common in the Temple Mountain member of the Chinle formation (R. C. Robeck and H. B. Dyer, written communication). Several small uranium deposits less than 100 tons in size have been found in these channels, but large deposits do not seem likely (Johnson, 1957). The sandstone lenses in these channels are probably too thin and discontinuous to provide good passageways for the laterally moving ore-bearing solutions. The argillacious nonchannel facies of the Temple Mountain member commonly overlies the sandstone lenses and may have prevented passage of solutions from the better aquifer (Moss Back member of Chinle formation) of the area to the permeable lenses in the Temple Mountain member. Then too, where the mottled purple, red, brown, and white coloring of the purple-white zone (Johnson, 1957) is well developed in the Temple Mountain member, limonite and hematite cement in the rock may have made it relatively impermeable. At best, the writer considers the Temple Mountain member only semifavorable for small deposits in these channels. Depths of greater than 1,000 feet to the Temple Mountain member everywhere

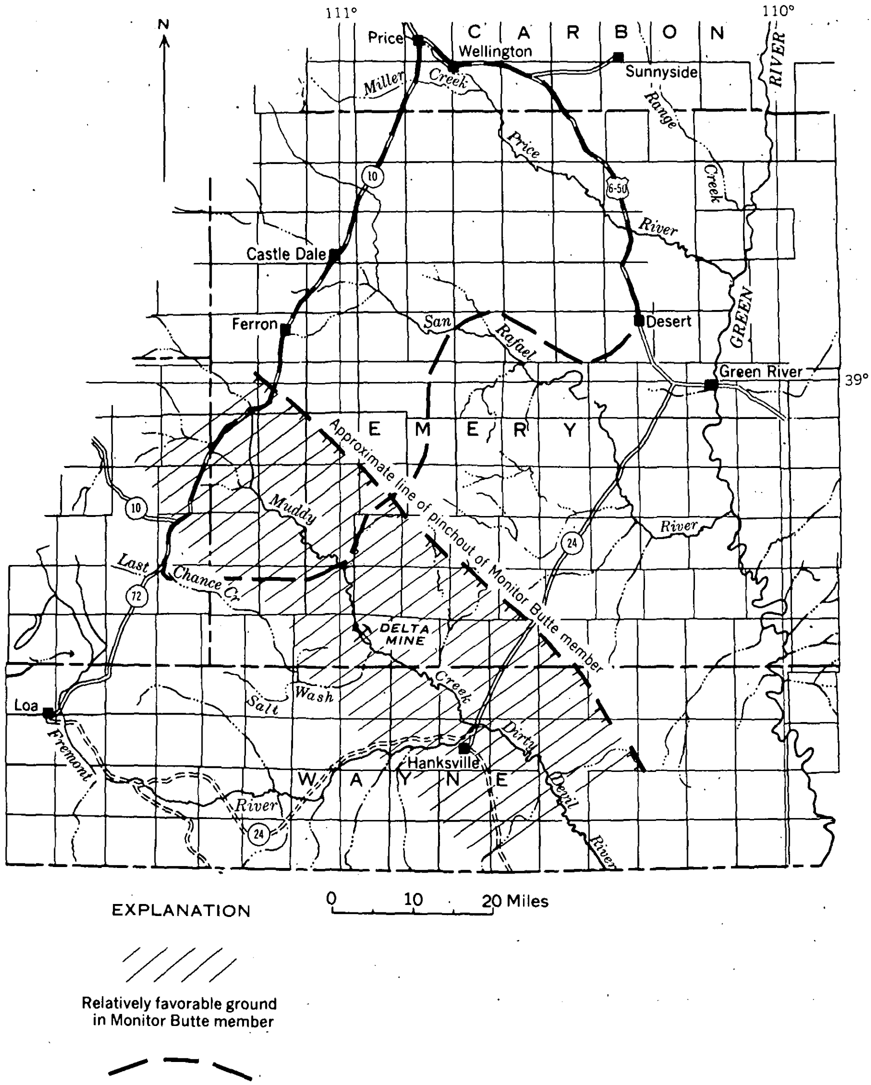


FIGURE 6.—Map showing ground relatively favorable for uranium deposits in the Monitor Butte member of the Chinle formation, Cedar Mountain area, Emery County, Utah.

in the Cedar Mountain area make exploration for these small deposits unattractive.

MONITOR BUTTE MEMBER OF THE CHINLE FORMATION

The Monitor Butte member underlies the southern part of the Cedar Mountain area at depths greater than 1,000 feet and pinches out to the north along a projected northwestward-trending line passing south of the town of Ferron (fig. 6). Where exposed in the

San Rafael Swell, the Monitor Butte contains several small uranium occurrences in thin sandstone lenses. The Delta mine (fig. 6) is in this unit and is in the thickest sandstone lens (as much as 30 feet thick) known in the Monitor Butte in that area. The deposit at the Delta mine is larger than 100,000 tons in size and has an average grade of about 0.40 percent U_3O_8. Other deposits of this size and grade may be well worth exploring for, even at depths such as those to be expected in the Cedar Mountain area. Because the Monitor Butte pinches out to the north, the Delta mine may be near the northern fringe of thick sandstone lenses of the Monitor Butte member. The Monitor Butte may be generally favorable in a broad belt roughly parallel to the line of pinchout of the member. If other sandstones of the Monitor Butte approaching the dimensions of the lens at the Delta mine are present in this belt, some of them may contain significant uranium deposits. Figure 6 shows the projection of this relatively favorable ground in the Monitor Butte member under the Cedar Mountain area.

MOSS BACK MEMBER OF THE CHINLE FORMATION

The Moss Back member underlies most of the Cedar Mountain area at depths greater than 1,000 feet and pinches out to the north along a projected northwestward-trending line of pinchout passing approximately halfway between Price and Castle Dale (fig. 7). Where exposed in the San Rafael Swell, the Moss Back contains uranium deposits or clusters of deposits as much as or larger than 100,000 tons in size. The larger deposits are in a northwestward-trending channel or channel system passing through Temple Mountain and Green Vein Mesa or in channels at the base of the Moss Back in that part of the Swell south of Temple Mountain and Green Vein Mesa (Johnson, 1957). The Moss Back in the northern half of the swell is a relatively thick massive blanketlike deposit with a minimum of scouring at the base and is considered relatively unfavorable. The northernmost exposures of Moss Back in the San Rafael Swell may be approaching the northern line of pinchout of the unit; but no discontinuity, sharp lensing, or scouring at the base is evident. Therefore, information gathered from exposures in the San Rafael Swell suggests that a broad belt of relatively favorable Moss Back may cover most of the southern third of the Cedar Mountain area (fig. 7). In this broad belt, channels or wide, shallow channel systems such as that passing through Temple Mountain and Green Vein Mesa are relatively favorable for uranium deposits in the 10,000- to 100,000-ton size range or possibly larger.

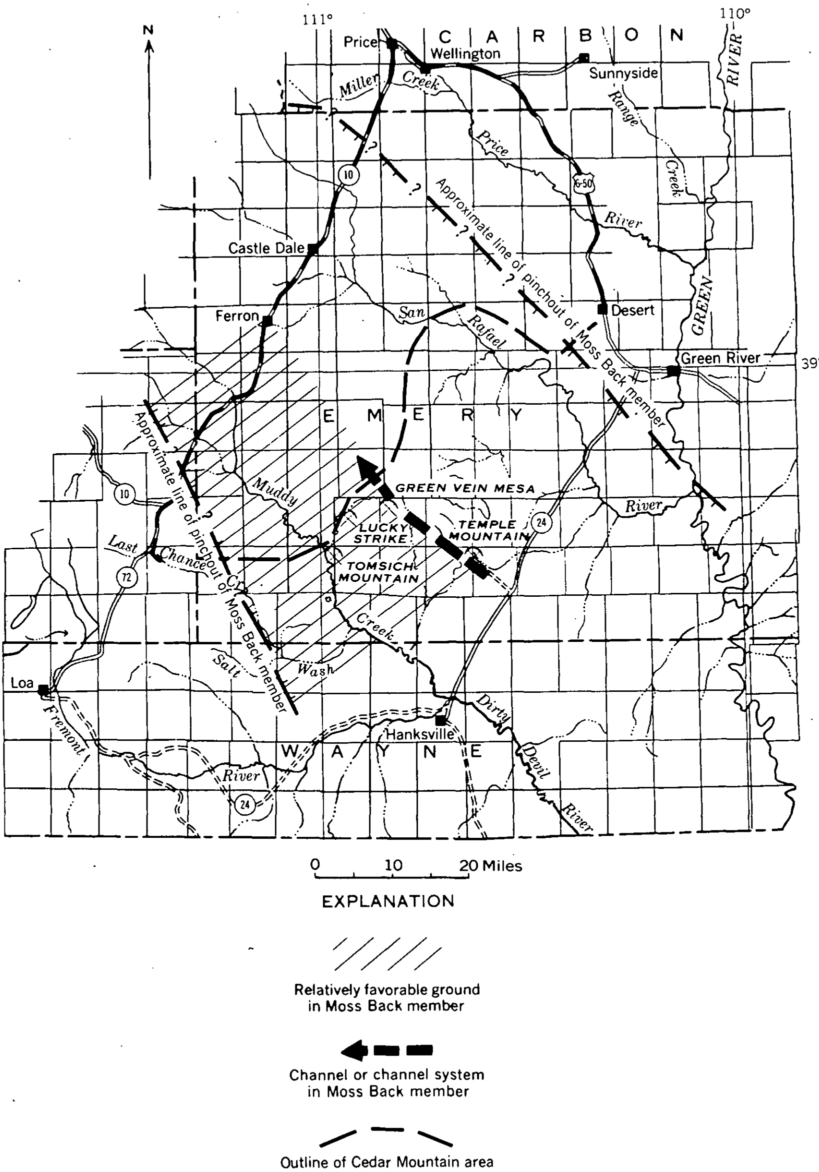


FIGURE 7.—Map showing ground relatively favorable for uranium deposits in the Moss Back member of the Chinle formation, Cedar Mountain area, Emery County, Utah.

CHURCH ROCK MEMBER OF THE CHINLE FORMATION

The Church Rock member where exposed in the San Rafael Swell contains a few occurrences of weakly mineralized uranium-bearing rock in light-colored sandstone lenses. One small deposit containing ore-grade material along a fault zone in the Church Rock is also known. None of these deposits is thought to contain any appreciable amount of ore and the Church Rock is considered to be similar lithologically and no more favorable under the Cedar Mountain area to the northwest.

Sandstones of the Church Rock member should provide passageways for ore-bearing solutions, however, and do have small amounts of carbonized plant material in them. In Grand County, Utah, they contain small ore deposits associated with carbonaceous material. If the Church Rock should contain appreciable amounts of carbonaceous material in the Cedar Mountain area, it could conceivably contain sizable uranium deposits.

GLEN CANYON GROUP

Uranium-bearing asphaltite occurs in association with pyrite and arsenic minerals in the Temple Mountain collapse structure in the San Rafael Swell (Keys and White, 1956), but as yet no evidence of ore deposits of this type has been found in the Cedar Mountain area. Exclusive of the Temple Mountain ore deposits, uranium in the Glen Canyon group in the San Rafael district and the Cedar Mountain area occurs only in very minor amounts in a few small fracture-controlled copper deposits. Because the Glen Canyon group is composed largely of clean blanketlike sandstone of relatively uniform lithology, it is thought unlikely to contain significant uranium deposits in the Cedar Mountain area.

ENTRADA SANDSTONE

Uranium and copper occur in minor amounts in several small deposits in the Entrada in T. 20 S., R. 9 E., Salt Lake meridian, in the Cedar Mountain area. The ore minerals are in a 1- to 5-foot-thick gray-green bleached zone associated with an inch-thick seam of carbonaceous material. The presence of ore minerals here is probably due to the reducing effects of the carbon. Normally the reddish colored Entrada in the Cedar Mountain area is totally lacking in carbonaceous material and is devoid of ore deposits. If the Entrada has more carbonaceous material to the west of its outcrop in the Cedar Mountain area, it could conceivably contain significant uranium deposits. There seems to be small chance of this, however, as carbonaceous material is not reported from the Entrada equivalents west of the Cedar Mountain area.

SALT WASH MEMBER OF THE MORRISON FORMATION

The Salt Wash member has been the source of about 90 percent of the uranium ore mined in the Cedar Mountain area through June 1955. Most of this has come from one ore deposit in the 100- to 1,000-ton size range in T. 20 S., R. 9 E., Salt Lake meridian, about

10 miles east of Ferron (fig. 8). In that part of the area, individual lenses of sandstone in the Salt Wash reach thicknesses of 30–40 feet. Elsewhere in the Cedar Mountain area individual lenses of sandstone in the Salt Wash are generally less than 20 feet thick.

Union Mines Development Corporation geologists studied 12 miles of outcrop of the Salt Wash member in the easternmost part of the Cedar Mountain area in December 1943 and January 1944, and determined that the Salt Wash was unfavorable for uranium deposits there and was thinner and more argillaceous toward the west (R. K. Kirkpatrick, written communication, 1944). The writer concurs with this opinion and thinks that the Salt Wash is relatively unfavorable for significant uranium deposits over the whole Cedar Mountain area except along the trend of the lobe of thicker Salt Wash extending through T. 20 S., R. 9 E., Salt Lake meridian (fig. 4).

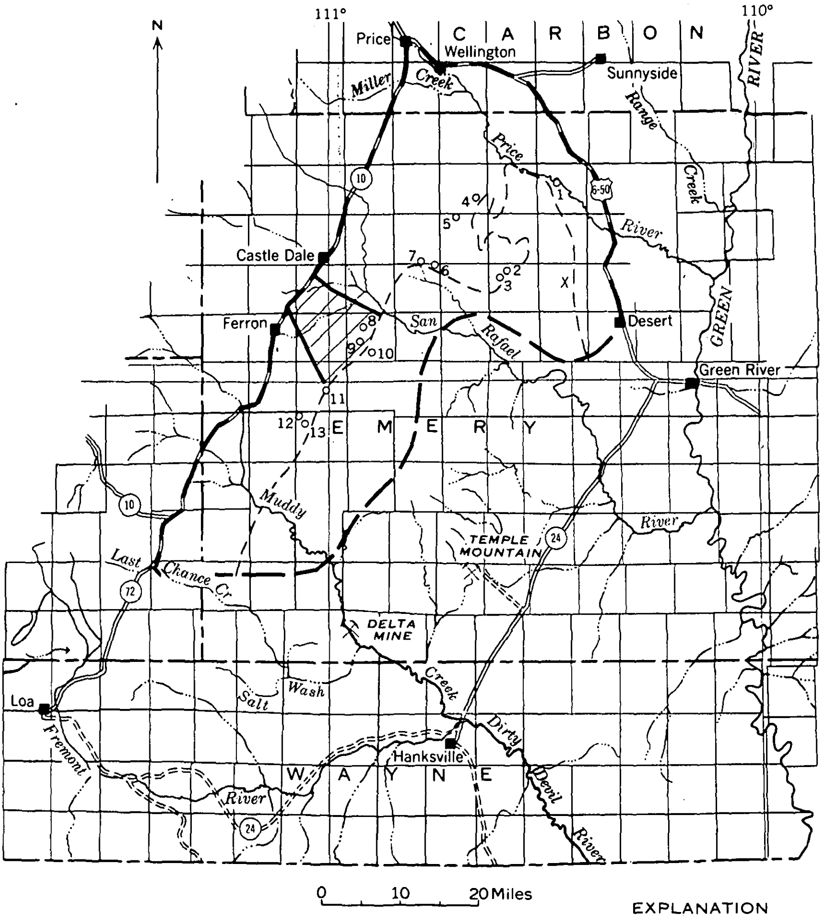
This northwestward-trending lobe of thicker Salt Wash probably represents a trunk channel system on the fan of the Salt Wash. Within this lobe or channel system, individual fluviatile sandstone lenses are thicker than is common elsewhere in the Cedar Mountain area, and the Salt Wash is relatively favorable for ore deposits up to about 1,000 tons in size (fig. 8). Larger deposits in the Salt Wash in the Cedar Mountain area are thought unlikely because of the rarity of sandstone lenses larger than 30–40 feet thick.

BRUSHY BASIN MEMBER OF THE MORRISON FORMATION

The Brushy Basin contains several uranium deposits less than 100 tons in size in the Cedar Mountain area, but only a few tons of ore has been produced. These deposits are in carbonaceous siltstone and claystone—although the Brushy Basin is commonly bentonitic and low in carbon—and are characterized by yellow secondary uranium minerals occurring as thin films or stains along joints in the blocky claystone and siltstone. The average grade of these submarginal deposits is thought to be about 0.05–0.10 percent U_3O_8, and fairly large tonnages of rock may also be present. Large deposits of higher grade are thought unlikely because carbonaceous material is rare in the Brushy Basin and sandstone lenses are relatively discontinuous.

CEDAR MOUNTAIN FORMATION

The lower conglomerate member of the Cedar Mountain formation is a thick, massive blanketlike bed of conglomerate across most of the Cedar Mountain area and contains little or no carbonaceous material. No uranium deposits occur in it to the writer's knowledge; and because of the blanketlike character and the lack of carbon, none of appreciable size are expected.



EXPLANATION

MINES OR PROSPECTS	ORE-BEARING UNIT
1 Rock Island group	Brushy Basin member
2 Unknown	Salt Wash member
3 Unknown	Salt Wash member
4 Cottonwood No 1	Salt Wash member
5 Cedaridge	Cedar Mountain formation
6 South Rim	Brushy Basin member
7 Cedar Mountain No 1	Brushy Basin member
8 Ronda; Rebecca knolls	Brushy Basin member
9 White Star group	Salt Wash member
10 Bell View and Copper Rock	Entrada sandstone
11 Unknown	Summerville formation
12 Unknown	Cedar Mountain formation
13 Unknown	Brushy Basin member
X Copper prospect in fault zone	Navajo sandstone

Outcrop of Salt Wash member of Morrison formation

Relatively favorable ground in Salt Wash member of Morrison formation

o

Uranium deposit with less than 100 tons production through June 1955

Outline of Cedar Mountain area

FIGURE 8.—Map showing ore deposits cropping out and ground relatively favorable for uranium deposits in the Morrison formation, Cedar Mountain area, Emery County, Utah.

The upper shale member of the Cedar Mountain formation is very similar to the Brushy Basin member of the Morrison formation and is predominantly shale and mudstone with minor sandstone lenses. Carbonaceous material is not abundant but is present in some places. Several minor uranium occurrences have been found in association with this carbon, but only a few tons of ore has been produced. The sparseness of carbonaceous material and the relative discontinuity of most of the sandstone lenses discourage expectation of large ore-grade uranium deposits. However, similarity to the Brushy Basin suggests the possibility that fairly large tonnages of rock averaging about 0.02 percent U_3O_8 may be present in carbonaceous siltstone and claystone beds at some places in this unit.

DAKOTA SANDSTONE

The Dakota sandstone is missing over much of the Cedar Mountain area and generally is very thin where present. No uranium deposits occur in it to the writer's knowledge, and its thinness and discontinuity probably make it unfavorable for deposits of significant size.

MANCOS SHALE

No uranium deposits are known to the writer in the Mancos in the Cedar Mountain area. None are expected in the shale members because of their relative impermeability and lack of variable lithology. The Ferron and Emery sandstone members, however, do contain minor uranium occurrences in other areas (W. D. Grundy, written communication, 1954) and could conceivably be uranium bearing in the Cedar Mountain area.

The Ferron sandstone member contains coal beds in the Cedar Mountain area and grades into a marine facies to the east (Davis, 1954). Southeast of the town of Emery, Utah, the Ferron is cross-bedded and resembles a fluviatile deposit in the upper part of the unit. It may be that farther to the west and southwest towards the source area of the Ferron it has a higher percentage of fluviatile deposits, and the interfingering of sandstone and mudstone lenses and the presence of carbonaceous material in these could provide traps and favorable host rocks for uranium deposits. So far this idea is untested, and no uranium deposits are known in the Ferron in that direction.

SUMMARY AND CONCLUSIONS

Uranium deposits in the Cedar Mountain area are similar to sandstone-type uranium deposits elsewhere on the Colorado Plateau. Ore deposits or minor uranium occurrences are known in the Entrada, Summerville, and Morrison formations and the Cedar Mountain formation in the area and are thought probable in the Chinle formation, and possibly in the Wingate and Navajo sandstones, at depth. Only the Chinle and Morrison formations and possibly the Cedar Mountain formation are thought to contain significant uranium deposits. The appraisal of unexposed units is based on the premise that primary sedimentary features are the major controls of ore deposits and favorable ground. If tectonic structural features exert a major control, extrapolation of geology and frequency of ore deposits from the San Rafael Swell to the Cedar Mountain area is not justified, and the uranium ore potential of the Cedar Mountain area may be considerably less than this report suggests.

The Monitor Butte and Moss Back members of the Chinle formation are present at depths of more than 1,000 feet in the Cedar Mountain area and are thought to be generally favorable for uranium deposits in the southern third of the area. Analogy to exposures in the San Rafael Swell suggests that sandstone lenses of the Monitor Butte member, if 30 feet or more thick, may contain uranium deposits 100,000 tons or more in size and that channels or wide, shallow channel systems (such as that passing through Temple Mountain and Green Vein Mesa in the neighboring San Rafael Swell) in the Moss Back member are relatively favorable for uranium deposits 10,000–100,000 tons or more in size.

The Salt Wash member of the Morrison formation has been the source of about 90 percent of all uranium ore mined in the Cedar Mountain area through June 1955, but no ore deposits larger than 1,000 tons in size have been found. This unit is considered generally unfavorable for significant uranium deposits in the Cedar Mountain area except in a belt coinciding with a lobe of thicker Salt Wash trending northwestward through T. 20 S., R. 9 E., Salt Lake meridian. This thicker Salt Wash is thought to represent the position of a trunk channel system or major drainage area on the ancient depositional fan of the Salt Wash.

Minor uranium ore deposits and occurrences of mineralized rock are known in the Brushy Basin member of the Morrison formation and in the upper shale member of the Cedar Mountain formation in the Cedar Mountain area. The uranium in these deposits is associated with carbonaceous siltstone and claystone, and the grade is low. It seems possible, however, that fairly large tonnages of rock averaging about 0.02 percent U_3O_8 may be present in these units.

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