Summary of Investigations of Uranium Deposits in the Pumpkin Buttes Area, Johnson and Campbell Counties, Wyoming

By M. L. Troyer, E. J. McKay, P. E. Soister, and S. R. Wallace

Trace Elements Investigations Report 345

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SUMMARY OF INVESTIGATIONS OF URANIUM DEPOSITS IN THE PUMPKIN BUTTES AREA, JOHNSON AND CAMPBELL COUNTIES, WYOMING*

By

Max L. Troyer, Edward J. McKay, Paul E. Soister, and Stewart R. Wallace

July 1953

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and Stewart R. Wallace

ABSTRACT

Uranium minerals were discovered in the Pumpkin Buttes area, Campbell and Johnson Counties by the U. S. Geological Survey in October 1951. From June to November 1952, an area of about 750 square miles was examined for uranium deposits, and 211 localities with abnormally high radioactivity were found; uranium minerals are visible at 121 of these localities.

All known uranium mineralization is restricted to sandstones of the Wasatch formation, exclusive of sparsely disseminated uranium in the White River sandstone which caps the Pumpkin Buttes, and several localities on the Great Pine Ridge southwest of the Pumpkin Buttes where ironstone and clinker in the Fort Union formation have above normal radioactivity. The uranium occurrences in the Wasatch formation are in a red sandstone zone 450 to 900 feet above the base of formation and are of two types: (1) small concretionary masses of uranium, iron, and manganese minerals in sandstone and (2) irregular zones in which uranium minerals are disseminated in sandstone. The second type is usually larger but lower grade than the first type.

Most of the localities at which uranium occurs are in a north-trending belt approximately 60 miles long with a maximum width of 18 miles.

INTRODUCTION

Location, culture, and accessibility

Uranium was discovered in the Pumpkin Buttes area by the U. S. Geological Survey in October 1951, and a brief reconnaissance study was made in mid-November of that year (Love, 1952). In June 1952, investigations were resumed to search for additional concentrations of uranium, to study distribution, habit, and occurrence of such concentrations, and to use the information thus obtained as a guide in outlining areas favorable for the occurrence of uranium deposits. The results of the work are presented in this report.

In the vicinity of Pumpkin Buttes all rocks known to contain uranium in other than trace amounts are sandstones of the Wasatch formation, and the sandstones in about 100 square miles were mapped by reconnaissance methods. About 70 square miles of this mapping is shown on figure 1. The remainder of the mapped area is west of the area shown on figure 1 where topographic sheets are lacking. Areas favorable for the occurrence of uranium east of the area of mapped sandstones also are shown on figure 1.

Approximately 7,000 feet of stratigraphic section were measured and more than 200 localities were examined where anomalous radioactivity was detected and reported by U. S. Geological Survey and Atomic Energy Commission planes equipped with scintillation type counters. The localities where uranium minerals were seen or above normal radioactivity was detected on the ground are shown on figure 3 and described in table 1.

Physical exploration in the area by the Geological Survey consisted of about 2,500 feet of drilling with a jeep-mounted auger and the excavation of about 5,000 cubic yards of material by bulldozing.

This work is a part of the program of exploration for radioactive minerals being conducted by the U. S. Geological Survey on the behalf of the Division of Raw Materials, U. S. Atomic Energy Commission.

The Pumpkin Buttes area (fig. 2) includes about 750 square miles in southwestern Campbell County and southeastern Johnson County, Wyo., in the west-central part of the Powder River Basin. The southern part of the area is crossed by State Highway 387, and the eastern edge is accessible by a graveled road locally known as the Savageton Route. One graded dirt road leads into the area from near the northeast corner and ends at the Jack Christensen Ranch southwest of the North Butte. Most of the area is accessible by ranch roads and trails that are in fair condition during the summer months.

Gillette, the county seat of Campbell County, with a population of about 2,000 is the largest town serving the region, and is about 30 miles northeast of the northeast corner of the Pumpkin Buttes area. Kaycee, Sussex, Edgerton, and Midwest are small towns 15 to 20 miles west and southwest of the Buttes. Access to the area from these towns is by private roads.

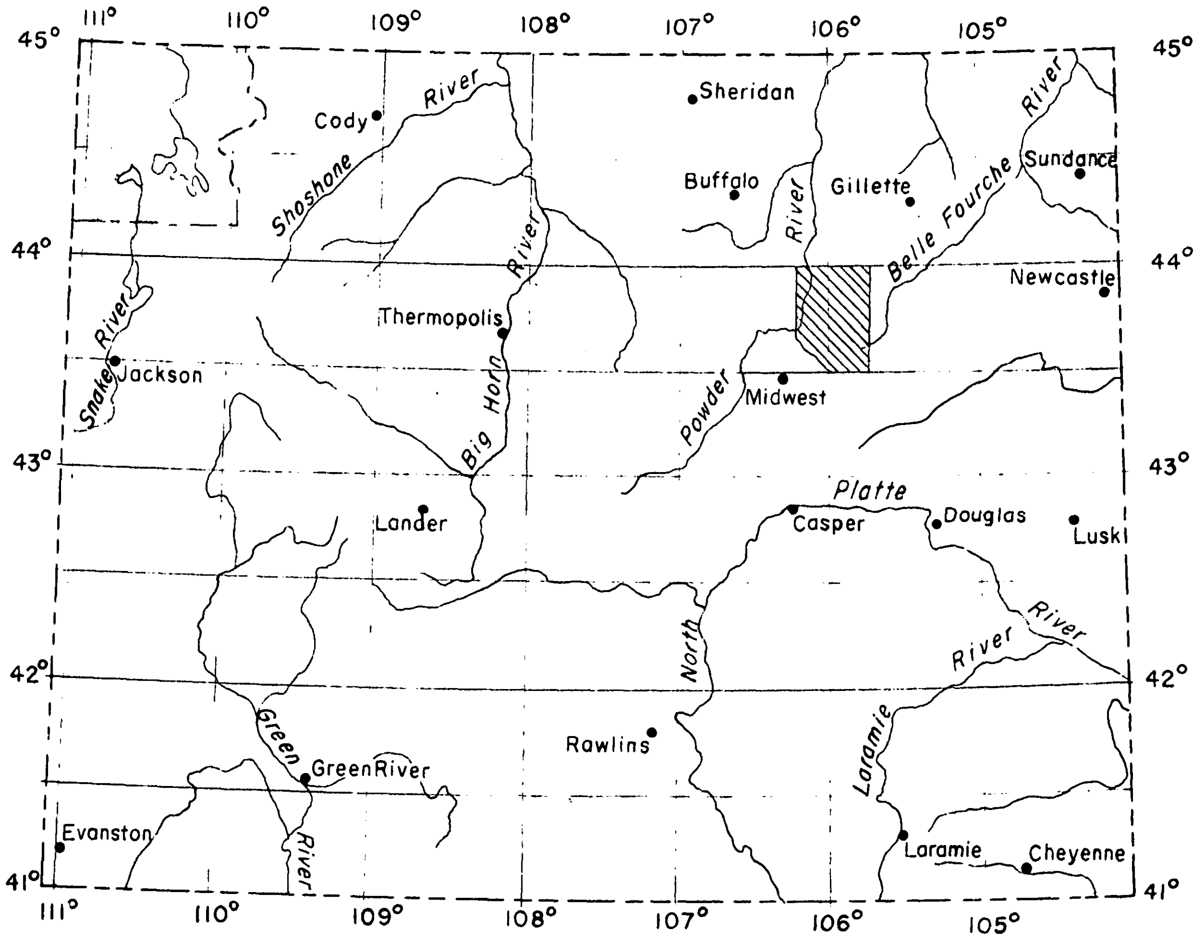


FIGURE 2. INDEX MAP OF WYOMING SHOWING LOCATION OF THE PUMPKIN BUTTES AREA

Physical features

The Pumpkin Buttes are situated close to the divide between the Powder River and the Belle Fourche River drainage systems. The Buttes rise about 1,000 feet above the surrounding country and are a prominent landmark visible for as much as 80 miles. The land north and east of the Buttes is grass-covered and gently rolling; relief between divides and adjacent drainages is commonly less than 200 feet. The land southwest and west of the Buttes is dissected by numerous deeply incised valleys and in a few places badlands have developed.

The northern and northwestern two-thirds of the region are drained by the Powder River and its ephemeral tributaries, the Dry Fork, Cottonwood Creek, Willow Creek, and Pumpkin Creek (fig. 3). The area south of State Highway 387 is drained by Antelope Creek, which is a part of the Cheyenne River drainage. The eastern edge of the area is in the Belle Fourche River drainage. Vegetation is mainly grass and sagebrush; small conifers are found on the upper slopes of the Buttes and some cottonwood trees grow along the major valley bottoms west of the Buttes.

Acknowledgments

Much of the information used in this report was gathered by the U. S. Geological Survey and the Atomic Energy Commission planes equipped with scintillation detectors. Spectrographic, chemical, and radioactivity analyses were made in the U. S. Geological Survey's Trace Elements Denver

Laboratory. The Denver Radiation instrument shop of the Geological Survey furnished and kept in operating condition the many and varied radiation instruments used by the field party. Arthur J. Gude, 3rd, made X-ray analyses of some of the uranium minerals. Paleobotanical and vertebrate specimens collected in the area were identified by R. W. Brown and Margaret J. Hough respectively. J. D. Love measured many of the stratigraphic sections. D. F. Davidson, R. Hay, T. Scott, W. C. Culbertson, and E. D. Patterson worked on the project at various times during the field season. Ranchers living in the area and personnel of private companies working in the vicinity cooperated in many ways.

GEOLOGIC SETTING

The Powder River Basin is a large topographic and structural basin that covers most of the northeast quarter of Wyoming and extends northward into Montana. The basin is bordered on the east by the Black Hills, on the southeast by the Hartville Uplift, on the south and southwest by Casper Mountain and the Powder River Lineament, and on the west by the Bighorn Mountains.

The structural axis of the basin is near the western side, and all but the southwest part of the Pumpkin Buttes area lies east of the axis (fig. 3). In the immediate vicinity of the Buttes, the Wasatch formation dips generally west and northwest. Except for local diagenetic and depositional features, the beds are nearly horizontal; dips range from less than 30 feet per mile east of the Buttes to more than 100 feet per mile in the area west of the Buttes.

Figure 4 is a generalized structure contour map of the Pumpkin Buttes area compiled from limited data. The Buttes are on the west flank of a broad north-northwest plunging anticline, the east flank of which is described by Wegeman, Howell, and Dobbin (1928). A slight syncline and anticline are in the northeastern part of the area.

STRATIGRAPHY

General statement

Most of the area covered by this report is underlain by the Wasatch formation of Eocene age. A thin band of Fort Union formation of Paleocene age crops out along the Great Pine Ridge escarpment in the southwestern corner of the area, and the White River formation of Oligocene age caps the Pumpkin Buttes.

Fort Union formation

The Fort Union formation is a sequence almost 3,000 feet thick that is made up of gray, fine-grained sandstone, bluish-gray claystone, and coal beds. Beds of coarse-grained, cross-bedded sandstone in the upper part of the formation in the southwest part of the area, and for some

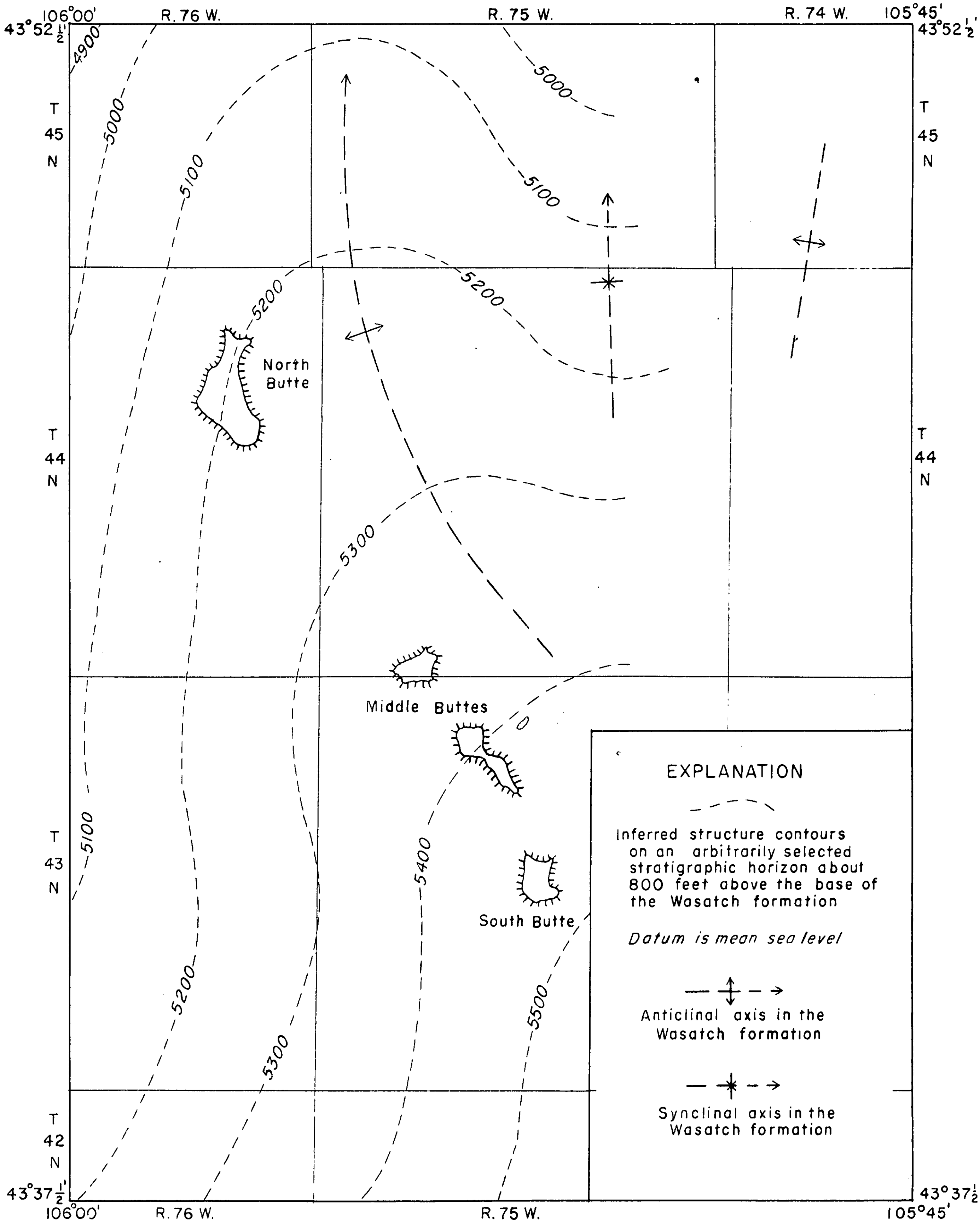


FIGURE 4.- STRUCTURE CONTOUR SKETCH MAP OF THE EAST CENTRAL PART OF THE PUMPKIN BUTTES AREA

1 0 1 2 3 Miles

distance to the northwest and the southeast, are expressed topographically by Great Pine Ridge. Some of the sandstone is ferruginous. The upper limit of the formation was arbitrarily placed by Wegeman, Howell, and Dobbin (1928) at the top of their coal bed H (See figure 5.) but G. Horn, U. S. Geological Survey, (personal communication, 1953) working in the vicinity of the Sussex oil field found that coal bed H occurs progressively lower in the section northwest of the Sussex oil field. R. K. Hose, U.S. Geological Survey (personal communication, 1953) placed the Fort Union-Wasatch boundary at the base of the stratigraphically lowest red siltstone in the Crazy Woman Creek area northwest of the Pumpkin Buttes area and that practice was followed in the Pumpkin Buttes area. The upper 550 feet of the Fort Union formation measured in NE1/4 sec. 3, T. 42 N., R. 78 W. is illustrated in the composite stratigraphic section (fig. 5).

Wasatch formation

The Wasatch formation in the Pumpkin Buttes area consists of variegated claystone, relatively continuous thin beds of coal, carbonaceous shale, and thin-bedded sandstone and lenticular, cross-bedded, medium- to coarse-grained sandstone (fig. 5). Vertebrate fossils collected during the summer of 1952 established an early Eocene age for the major part of the Wasatch formation in the west-central Powder River Basin. No middle or upper Eocene rocks are recognized.

The Wasatch formation in the Pumpkin Buttes area is about 1,500 feet thick in the composite section (fig. 5). The lower 500 feet of the Wasatch formation were measured near Great Pine Ridge (SW1/4 sec. 35, T. 43 N., R. 78 W.) and the upper 1,000 feet were measured on North Pumpkin Butte (secs. 2 and 10, T. 44 N., R. 76 W.). The two parts of the composite section were connected by tracing carbonaceous shale beds a distance of about 12 miles.

The Wasatch formation is composed of approximately 3 parts shale, claystone, and siltstone to 1 part sandstone. In overall aspect the Wasatch is lithologically a mudstone sequence interbedded with sandstone lenses. Reconnaissance by Davidson (1953) indicates in a preliminary way that fine-grained material is more abundant northwest of the Pumpkin Buttes area and coarse-grained material is more abundant southeast of the area.

A red sandstone zone (fig. 2) in the Wasatch formation includes essentially all known uranium occurrences in the Pumpkin Buttes area. The zone is about 450 feet thick in the line of the measured section, but at other places it is more than 500 feet thick. The sandstone in this zone typically is massive and cross-bedded, medium- to coarse-grained, feldspathic, and friable to moderately well-cemented; a few beds are tuffaceous. Lime-cemented concretions form cannon balls, irregular masses, and elongate bodies ten to several hundred feet long and 1 to 6 feet in diameter. The long axes of most of the irregular masses and the elongate bodies are oriented northwest.

Thin conglomerate beds within the sandstone are common. The pieces in the conglomerate are clay fragments as much as 2 inches in diameter. Fragments of plant material, either coalified or replaced by fine-grained silica are locally abundant. Some of the coalified material has been replaced by iron sulfide.

Much of the sandstone in the uranium-bearing zone is colored various shades of red and brown by iron oxides, but the staining is not uniform, either stratigraphically or laterally, and gray and buff colored sandstone is common. Most of the sandstone units range from 30 to 60 feet in thickness, but in places some are over 100 feet thick. The sandstones transgress the section, interfinger with finer clastic material, and are lenticular. They are thought to be floodplain and channel deposits. In some places the sandstone fills channels cut in underlying beds of shale, mudstone, and siltstone, but in many places the sandstones grade laterally into finer-grained sediments. Individual beds of sandstones range in extent from a few hundred yards to several miles. They are not consistent in stratigraphic position and few individual beds can be traced for any distance. Except for color, sandstones in the upper 650 feet of the Wasatch appear to be similar to those in the uranium-bearing zone.

White River formation

The White River formation caps all the Pumpkin Buttes and is 30 to 75 feet thick. The formation is composed of very coarse-grained to conglomeratic sandstone made resistant by siliceous cement. Remnants of white and pink tuff and bentonitic claystone, a few feet thick, overlie the caprock in a few places. Vertebrate fossils collected by Love (1952) established the early Oligocene age of these strata.

The White River formation overlies the Wasatch formation with an erosional unconformity marked by local channel filling. The pre-Oligocene surface was nearly horizontal in a northwest-southeast direction and, in the vicinity of Pumpkin Buttes, was cut on the underlying west and northwest dipping beds of the Wasatch formation.

URANIUM DEPOSITS

Essentially all known concentrations of uranium occur in the sandstones of the uranium-bearing red sandstone zone 450 to 900 feet above the base of the Wasatch formation (fig. 5). The uranium occurrences are of two principal types: (1) Concretionary type: - Small irregularly shaped concretionary masses of uranium, iron, and manganese minerals in sandstone. The uranium content of these concretions is very high. (2) Disseminated type: - Irregular zones in which uranium minerals are disseminated in sandstone with little or no visible iron and manganese. Known deposits of this type are much larger but much lower grade than the concretionary type.

Uranium minerals were found at 121 of the 211 localities shown on figure 3; above normal radioactivity was detected either by airborne or ground equipment at the remaining 90 localities, but visible uranium minerals were not found. Ninety-six of the 121 occurrences are of the concretionary type, and 6 are of the disseminated type. Due to poor exposures the remaining 9 occurrences cannot be classified.

The largest individual concretionary deposit found is about 10 feet in its longest dimension. The concretions tend to occur in groups. In some places half a dozen or so small concretions may be found in an area of a few tens of square feet. At other places, concretions may be found in an area of several thousand square yards. The density of distribution of the concretions at most places cannot be determined because of lack of exposures. Additional physical exploration is necessary to obtain data from which the frequency of occurrences of concretions in such areas can be predicted. Deposits of the disseminated type were discovered late in the field season of 1952 and little is known about them. The estimated size of the largest deposit is 100 by 800 feet with the thickness varying from a few inches to 10 feet.

MINERALOGY

The information presented below is based largely on the study of 10 thin sections cut from specimens collected at locality 119, sec. 36, T. 43 N., R. 76 W., a concretionary type deposit.

The sandstone at the deposit is a medium- to coarse-grained friable sandstone that contains three types of concretions: (1) those in which the sand grains are cemented and partly replaced by calcite; (2) those in which the sand grains are cemented and partly replaced by both calcite and iron and manganese oxides; and (3) those in which the sand grains are cemented and partly replaced by iron and manganese oxides.

The type 2 concretions contain more uranium than types 1 and 3, which commonly contain little or no uranium. Many of the uranium-bearing concretions exhibit a crude concentric banding with alternating but discontinuous zones of black, brown, and yellow mineralization and barren or only slightly mineralized sandstone. The three types seem to represent successive stages in the mineralization of the sandstone, and all gradations exist between the three types. A description of the unmineralized sandstone and of the successive changes produced by the development of the various types of concretions is given below.

Sub-angular to sub-rounded quartz grains are the dominant constituent (40-60 percent) of the non-concretionary sandstone. Plagioclase (andesine and oligoclase) and microcline constitute about 5 to 10 percent of the rock. Most of the feldspar is remarkably fresh and clear, but a few grains in every section are badly altered to sericite or allophane or both. Accessory detrital minerals include epidote, biotite, muscovite, garnet, tourmaline, chlorite, sphene, and zircon.

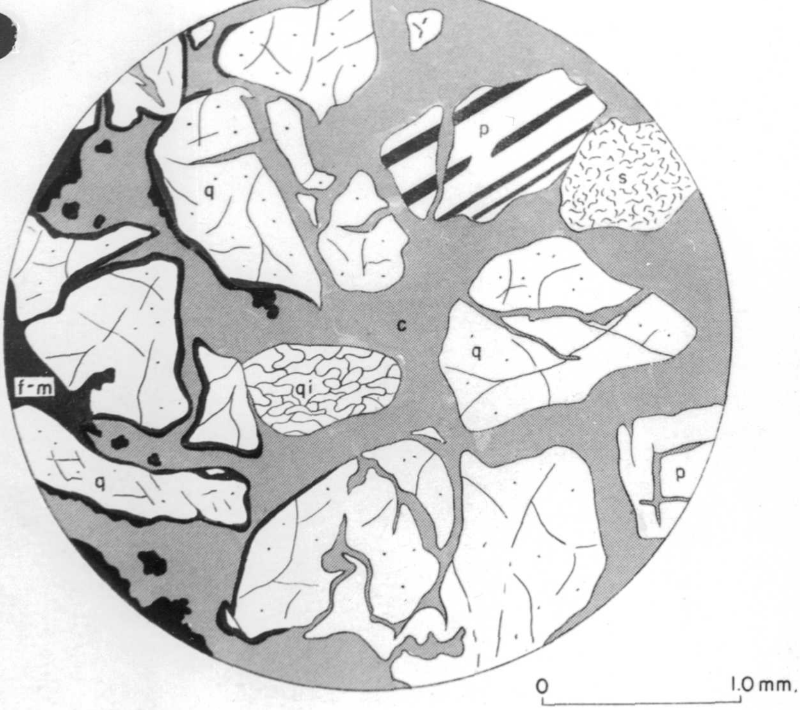
The rock is poorly sorted and much of the space between mineral grains is taken up with fine fragments of shale which constitute an estimated 15 to 20 percent of the rock. Calcite cement fills the interstices.

The sandstone of the concretions is well sorted and cleaner with relatively few shale fragments. This suggests that the development of concretions may be correlated with greater permeability. The quartz and feldspar grains in the calcite concretions (type 1) are commonly ruptured, and the cracks and breaks healed with calcite which both fills the fractures and replaces the quartz and feldspar (fig. 6, A). Some of the plagioclase has been replaced along cleavage cracks (fig. 6, A). The cause of the fractures is unknown, but few sand grains in specimens that were not taken from concretions show this feature.

The uranium-bearing concretions (type 2) are similar to the calcite concretions except that calcite has been partly replaced by iron and manganese oxides, and at a later stage by uranophane and minor amounts of a carnotite-tyuyamunite (?) mineral. Replacement of calcite by iron and manganese oxides starts along the grain boundaries. This stage is illustrated in the left part of figure 6, A. As replacement proceeds, the selvages of iron and manganese oxides surrounding the grains thicken, and irregular spots or islands of these minerals develop in the interstitial calcite. Finally the calcite cement is completely replaced, and the quartz and feldspar grains are attacked. This stage is shown in the left part of figure 6, B., and results in the type 3 concretion which carries little uranium.

Uranophane does not develop in the absence of the iron and manganese oxides, but in the sections studied, it does not replace either the iron and manganese oxides or the relict mineral grains; apparently some calcite must be present as a site for replacement. If some calcite cement remains, then uranophane may develop. This stage is shown in the central and right parts of figure 6, B. Bladed aggregates of uranophane wrap around the larger grains of quartz and feldspar, but do not replace them; small grains of quartz and islands of iron-manganese oxides are completely enclosed by the uranophane without disturbing the orientation of the individual uranophane crystals (fig. 6, B). Note how the uranophane fibers extend into the calcite, but terminate abruptly against the quartz grains or against the iron-manganese oxide selvage which surrounds some of the grains.

The significance of the association of uranium and the iron and manganese oxides is unknown. In a few places the opaque material exhibits rectangular outlines suggesting that some of it may be pseudomorphic after pyrite. This feature is shown at the border of the black mineralization near the top of figure 6, B.



A.

Fractured grains of quartz (q) and plagioclase (p) and rock fragments, quartzite (qi) and shale (s) in calcite cement (c). Iron and manganese oxides (f-m) replace calcite in left part of field. Thin section TW-143.

B.

Similar to A., but iron and manganese oxides completely replace calcite cement and attack the allogenic mineral grains at left edge of field. At center and right, sheaf-like aggregates of bladed uranophane (u) replace the calcite, but not the iron-manganese oxides or the quartz or feldspar. Composite of thin section TW-140 and two sections of TW-141, showing gradational changes in mineralization.

Figure 6.--Sketches of thin sections from concretionary type deposit, showing progressive stages of mineralization. Specimens from the South School Section roll, #119, sec. 36, T. 43 N., R. 76 W.

Thin sections of specimens from other concretionary type deposits, from disseminated type deposits, and from areas in which there are no known deposits are not yet available for study. X-ray analyses indicate that the dominant uranium mineral in unclassified type deposits at locality 3 and at a locality in sec. 9, R. 73 W., T. 37 N., approximately 25 miles south of the Pumpkin Buttes area, is meta-tyuyamunite. Richard Kellagher (personal communication) has reported manganosite (MnO) from locality 92, sec. 28, T. 43 N., R. 75 W. M.E. Thompson (Weeks, 1952) has identified liebigite ($Ca_2U(CO_3)_4 \cdot 10H_2O$) from locality 29, sec. 4, T. 42 N., R. 76 W. The mineral occurs as a yellow-green efflorescence at a small water seep in sandstone exposed in a steep cutbank.

The mineralized concretions at locality 31 contain the usual iron-manganese oxides in association with both orange and yellow uranium minerals. The orange mineral has been identified by X-ray as carnotite; the yellow material is a mixture of carnotite and an unidentified mineral.

LIMITS OF KNOWN PRINCIPAL URANIUM MINERALIZATION

The area containing the principal known occurrences of uranium in the Pumpkin Buttes area is shown on figure 7. North and northwest of this area the sandstones of the uranium-bearing zone have not been recognized and have either been removed by erosion or grade laterally into claystone, shale, and siltstone. The attitude of the beds and surface elevations indicate that east of R. 73 W. and west of R. 77 W. the rocks exposed are

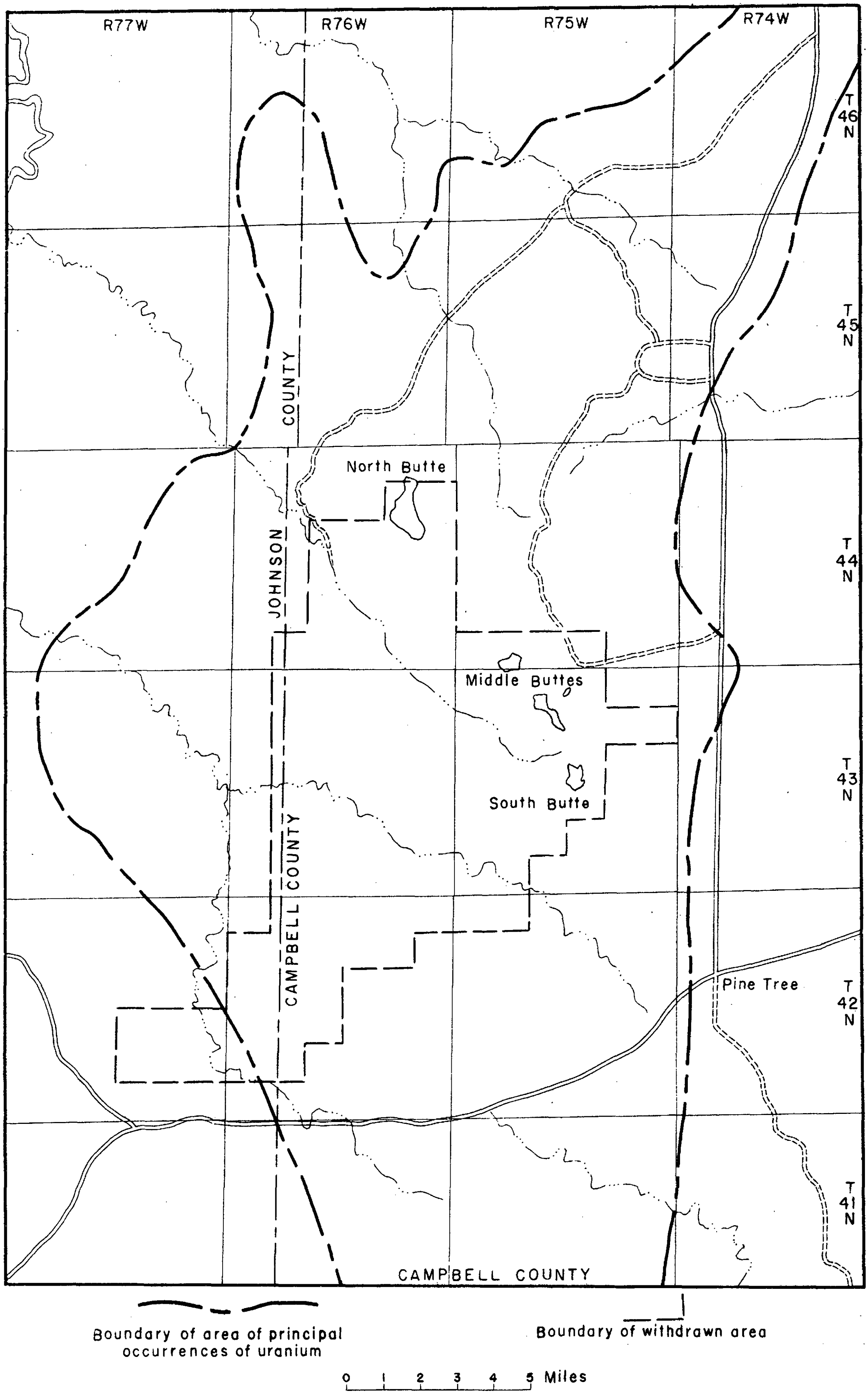


FIGURE 7.--MAP SHOWING AREA OF PRINCIPAL OCCURRENCES OF URANIUM IN PUMPKIN BUTTES AREA, WYOMING.

stratigraphically below the uranium-bearing sandstone zone of the Wasatch formation. Anomalous radioactivity detected in siltstones, ironstones, and in one or two locally coarse-grained sandstones west of the favorable area is not associated with visible uranium mineralization.

The southern limit of the area favorable for uranium deposits is still open to question. The area extending about 6 miles south of State Highway 387 has been checked on the ground by reconnaissance methods and has been covered by the U. S. Geological Survey and Atomic Energy Commission airborne scintillation detectors. Only one radioactivity anomaly was found. In November 1952, the Atomic Energy Commission plane discovered radioactivity anomalies at 3 localities 16 to 25 miles south of the Pumpkin Buttes area of this report: (1) secs. 34 or 35, T. 38 N., R. 73 W.; (2) sec. 28, T. 37 N., R. 73 W.; and (3) sec. 16, T. 38 N., R. 74 W. These three points were ground checked in February 1953 and a concretionary type deposit was found at the first locality. No uranium minerals are visible at the other two localities, but both show above average radioactivity over 200 to 300 square yards. Since these three discoveries, other deposits have been found in the same vicinity by private company geologists.

GUIDES TO PROSPECTING

Listed below are certain features which the writers feel will be helpful in the search for new deposits in the Pumpkin Buttes area:

(1) All uranium deposits of ore grade (0.1 percent or more uranium) are in sandstones of the red sandstone zone 450 to 900 feet above the

base of the Wasatch formation. Most of the known deposits are in iron-stained sandstone or in gray- to buff-colored sandstone that is closely associated, either laterally or vertically, with iron-stained sandstone. The color of the red sandstones and the soil derived from them photographs darker than the unstained sandstone, and the darker areas shown on the aerial photographs are generally favorable for uranium mineralization.

(2) Conspicuous dark-brown to black concretions of iron and manganese oxides are commonly associated with the uranium-bearing concretions and some of the uranium-bearing concretions have dark outershells of iron and manganese oxides. Many of the concretionary-type deposits were discovered by noting the color contrast between dark colored iron and manganese oxides and the host sandstone.

(3) Most of the concretionary type deposits contain several individual rolls or concretions. If one concretion is found, a thorough search should be made in the immediate vicinity for additional concentrations of uranium minerals.

(4) Water samples from shallow wells and springs in the vicinity of known deposits contain as much as 50 times the amount of uranium present in water from wells in areas where no uranium deposits are known. Only a few analyses are available, but systematic sampling of water from wells and springs may prove helpful in locating new deposits.

PHYSICAL EXPLORATION

Physical exploration by the Geological Survey during 1952 consisted of about 2,500 feet (94 holes) of drilling with a jeep-mounted power auger and the excavation of about 5,000 cubic yards of earth by bulldozing.

Concretionary type deposits at 4 localities--16, 17, 26, and 119--were drilled and an area approximately 100 by 200 feet was bulldozed at locality 31. The object was to determine the occurrence and distribution of uranium-bearing concretions at depth in areas where there was a concentration of individual concretions at the surface and in areas which showed only sparse mineralization. Where possible, holes were drilled through the ore-bearing sandstone and logged with a portable gamma ray logging unit. Some holes did not reach the desired depth due to layers of hard, calcareous or ferruginous and manganiferous sandstone which the auger could not penetrate; other holes caved and filled as the auger was withdrawn. In about 35 percent of the holes the sandstone could not be checked by the probe through its entire thickness.

Information obtained from the drilling and the bulldozing indicates that: (1) Ore-bearing concretions at the surface probably indicate that similar concretions are present throughout the thickness of the sandstone and in about the same concentration as that seen at the surface, and (2) because of the irregular distribution of uranium in relatively small high grade rolls, bulldozing is believed to be more effective than augering where cover is not too thick.

Table 1.—Localities of known uranium mineralization or anomalous high radioactivity, Pumpkin Buttes area, Wyoming.

Loc. No.	Location 1/	Field Sample No.	Equivalent Uranium (percent)	Uranium (percent)	V_2O_5 (percent)	Mn (percent)	Other (percent)	2/	3/	4/	Remarks
1	15-45-75	TW-65	3.7	3.85	0.80	1.19		S	M	G	
2	22-45-75	TW-64	0.24	0.21	0.26	0.248	10.83 CO_2	S	M	G	
3	22-45-75	TW-63	9.1	14.62	3.32	0.50		S	M	G	
4	29-45-75	TW-7	14.2	17.08	0.38	1.17		S	M	U	
5	28-45-75	TW-21	10.0	8.43	1.51	7.4		S	M	G	
6	27-45-75	TW-5	3.2	3.98	1.96	7.56		S	M	G	
7	33-45-75	TW-6	6.7	7.7	2.69	0.63		S	M	U	
8	34-45-75								M	G	
9	36-45-76	LW-86	5.7	6.34	0.47	1.1		S	M	G	
		LW-87	4.2	4.72	1.75	5.7		S			
10	35-45-76	LW-82	1.9	2.97	1.21	0.63		S	M	G	
		LW-83	2.1	2.30	0.55	5.8		S			
		LW-84	2.3	2.43	0.92	5.3		S			
		LW-85	5.2	5.62	0.64	2.5		S			
11	1-44-76	LW-121	20.0	23.6	0.18	0.36		S	M	G	
12	12-44-75	TW-3	0.44	0.55	1.54	0.07		S	M	U	
		TW-4	0.004	0.003	0.32	0.10	7.28 CO_2	S			Host sandstone.
13	9-43-75	LW-100	8.5	12.85	1.79	3.6		S			
		LW-104	6.5	9.46	1.24	0.19		S	M	G	
		LW-105	0.06	0.079	0.1	0.12		S			Host sandstone.

1/ See figure 3.
2/ Type of sample: C - channel; S - selected.
3/ R - Locality of high radioactivity but no uranium minerals observed.
M - Locality of known uranium mineralization.
4/ Locality discovered by:
A - A.E.C. plane
U - U.S.G.S. plane
G - U.S.G.S. ground party

Table 1.—Localities of known uranium mineralization or anomalous high radioactivity, Pumpkin Buttes area, Wyoming—Continued

Loc. No.	Location 1/	Field Sample No.	Equivalent Uranium (percent)	Uranium (percent)	V_2O_5 (percent)	Mn (percent)	Other (percent)	2/	3/	4/	Remarks
14	15-43-76	LW-56	1.7	1.77	1.31			S			
		LW-57	0.006	0.004	0.05			C	M	G	Host sandstone.
15	22-43-76	LW-51	0.036	0.025	0.07			C	R	G	Near deposit.
16	22-43-76	LW-54	5.5	5.42	2.44			S			
		LW-55	0.018	0.013	0.04			C			Host sandstone.
		LW-59	0.003	0.002	0.06			S			Host sandstone.
		LW-60	0.009	0.010	0.04			S	M	U	Host sandstone.
		LW-61	0.26	0.19	0.86			S			Manganiferous part of deposit.
		LW-62	4.6	4.57	1.72			S			
		TW-41	0.007	0.004	0.06	0.147		C			Highly contaminated auger hole sample.
		TW-42	0.45	0.48	0.35	0.945	6.75 CO_2	C			
		TW-46	0.13	0.12	0.19	0.468	7.19 CO_2	C			Do.
17	22-43-76	LW-52	1.2	1.38	0.96			S	M	U	
		LW-53	0.006	0.004	0.07			C	M	U	Host sandstone.
18	22-43-76	LW-63	0.079	0.10	0.06			S			Upper 4 ft. of coal below sandstone.
		LW-64	0.037	0.008	0.10			C	M	G	Basal 5 ft. of sandstone.
19	22-43-76	LW-48	0.027	0.024	0.06			S			Top 5 ft. of coal below sandstone.
		LW-49	0.004	0.001	0.06			S			Host sandstone.
		LW-50	7.4	7.27	1.63			S	M	G	
20	19-43-75	LW-120	5.8	6.59	2.09	6.00		S	M	G	
		TW-38	0.34	0.34	1.02	6.70	4.15 CO_2	S			
21	30-43-75	LW-110	3.8	4.02	0.46	17.88		S	M	G	
22	25-43-75	LW-66	0.98	1.78	0.67			S			
		LW-67	0.021	0.020	0.04			S	M	G	Host sandstone.
		LW-68	0.008	0.007	0.08			S			Upper 0.25 of siltstone under ss.
		LW-69	0.31	0.53	0.53			S			Base of sandstone.

Table 1.--Localities of known uranium mineralization or anomalous high radioactivity, Pumpkin Buttes area, Wyoming--Continued

Loc. No.	Location 1/	Field Sample No.	Equivalent Uranium (percent)	Uranium (percent)	V_2O_5 (percent)	Mn (percent)	Other (percent)	2/	3/	4/	Remarks
23	36-43-76	LW-107	0.10	0.026	0.08	1.09		C	M	G	Host sandstone and uranium deposit.
		LW-108	0.023	0.003	0.05	1.11		C			Host sandstone.
		LW-109	0.031	0.025	0.07	0.76		C			
24	31-43-76								M	G	
25	35-43-76	TW-10	0.62	0.63	0.61	4.0	2.69 CO_2	S	M	G	
26	4-42-76	LW-88	7.6	9.7	0.68	1.2		S	M	G	
27	4-42-76								M	G	
28	4-42-76	TW-40	0.042	0.030	0.08	0.60	8.72 CO_2	C	M	G	Host sandstone and uranium deposit.
29	4-42-76	LW-112	1.1	0.085	0.15	0.17		S			
		LW-113	0.21	0.005	0.05	2.29		S	M	G	Manganiferous host sandstone.
30	2-42-76	TW-9	1.1	1.27	1.57	0.41		S			
		TW-39	0.98	0.99	1.15	2.42		S	M	G	
31	22-43-76	AEC-171	6.9	6.79			7.4 CaO				
				7.69	2.94		0.22 SO_4	S	M	G	
		AEC-172	2.5	2.5	1.29		10.2 CaO	S			
				3.09			0.33 SO_4				50 lbs. of average grade from bull-dozed deposit.
		LW-44	4.2	3.92	1.97			S			
		LW-45	0.54	0.54	0.35			C			Basal 1 ft. of host ss.
		LW-46	0.20	0.15	0.14			C			Basal 3 ft. of host ss.
		LW-47	0.009	0.007	0.10			C			Host sandstone.
32	5-45-75								R	A	
33	8-45-75	LW-122	0.89	1.42	0.31	6.20		S	M	G	
34	11-45-75								R	G	
35	11-45-75								M	U	
36	11-45-75								R	U	

Table 1.—Localities of known uranium mineralization or anomalous high radioactivity, Pumpkin Buttes area, Wyoming—Continued

Loc. No.	Location 1/	Field Sample No.	Equivalent Uranium (percent)	Uranium (percent)	V_2O_5 (percent)	Mn (percent)	Other (percent)	2/	3/	4/	Remarks
37	11-45-75	TW-106	1.7	2.27	1.00	0.237		C	M	G	Auger hole sample.
		TW-107	0.061	0.03	0.04	0.028		C			Auger hole sample.
38	11-45-75	TW-110	0.024	0.003	0.05	0.037		C	M	U	
39	15-45-75								M	G	
40	18-45-75								R	U	
41	22-45-75	TW-111	0.10	0.052	0.08	0.189		C	M	U	Auger hole sample.
42	30-45-75	TW-113	0.10	0.006	0.18	0.064		S	R	U	
43	33-45-75	TW-114	1.0	0.92	0.50	12.85		S	M	A	Manganese concretion.
44	34-45-75								R	U	
45	31-45-75								M	U	
46	36-45-76								M	A	
47	36-45-76								M	A	
48	36-45-76	TW-76	0.11	0.078	0.35	0.13		S	M	A	
49	30-46-76	TW-78	1.2	1.84	1.53	0.98		S			
		TW-79	0.13	0.084	0.13	0.05		S	M		
		TW-80	0.72	0.95	0.75	1.36		S			
		TW-81	0.20	0.032	0.58	0.27		S			
50	5-45-76								R	U	
51	5-45-76	TW-66	0.54	0.90	0.93	0.13		S	M	U	
		TW-67	0.063	0.064	0.25	0.10		S			
		TW-68	0.008	0.008	0.07	0.11		C			5 ft. sample.
		TW-124	0.27	0.47	1.24	0.027		S			
		TW-164	0.91	0.95							
		TW-165	0.71	1.26							
52	9-45-76	TW-70	0.013	0.013	0.05	0.13		C			10 ft. sample.
		TW-89	0.068	0.027	0.14	0.15		C	M	G	
		TW-90	0.22	0.19	0.11	0.37		S			
53	16-45-76								R	U	
54	16-45-76								M	U	

Table 1.--Localities of known uranium mineralization or anomalous high radioactivity, Pumpkin Buttes area, Wyoming--Continued

Loc. No.	Location 1/	Field Sample No.	Equivalent Uranium (percent)	Uranium (percent)	V_2O_5 (percent)	Mn (percent)	Other (percent)	2/	3/	4/	Remarks
55	15-45-76	TW-28	3.0	3.10	0.78	7.14		S	M	G	
56	21-45-76	TW-71	1.3	2.42	2.59	0.28		S	M	U	
		TW-72	0.036	0.013	0.16	0.14		C			6 ft. sample.
57	22-45-76	TW-35	0.023	0.014	0.19	0.258		S	M	G	
58	22-45-76	TW-34	0.21	0.17	0.29	7.05		S	M	G	
59	22-45-76	TW-112	0.06	0.023	0.08	0.277		C	M	U	
60	27-45-76								R	G	
61	26-45-76	TW-27	0.018	0.006	0.06	0.028		C	R	A	
62	26-45-76	TW-87	0.14	0.13	0.26	0.16		S	M	A	
		TW-88	0.18	0.17	0.46	0.07		S			
63	23-45-76								M	A	
64	24-45-76								M	A	
65	33-45-76								R	G	
66	35-45-76								M	U	
67	35-45-76	TW-8	6.0	9.35	1.54	0.02		S	M	U	
68	4-44-76								M	G	
69	1-44-77								R	G	
70	10-44-76	LW-123	9.2	11.6	0.37	7.60		S	M	G	
71	3-44-75	TW-82	2.4	2.84	0.42	2.25		S	M	A	
72	3-44-75	TW-83	0.84	1.03	0.64	1.25		S	M	A	
73	3-44-75	TW-85	0.067	0.038	0.17	0.14		S	M	A	
74	10-44-75	TW-84	2.7	2.94	0.92	6.40	9.07 CO_2	S	M	G	
75	10-44-75	TW-86	0.19	0.085	0.22	0.32		C	M	A	
76	12-44-75								R	U	
77	18-44-76	TW-33	0.39	0.28	0.38	0.173		S	M	G	
78	18-44-76								R	G	
79	18-44-76								M	G	
80	18-44-76								R	G	
81	24-44-76	LW-18	0.005	0.004				S			Coal below ss.
		LW-19	14.0	15.14				S	M	U	

Table 1.--Localities of known uranium mineralization or anomalous high radioactivity, Pumpkin Buttes area, Wyoming--Continued

Loc. No.	Location 1/	Field Sample No.	Equivalent Uranium (percent)	Uranium (percent)	V_2O_5 (percent)	Mn (percent)	Other (percent)	2/	3/	4/	Remarks
81	24-44-76	LW-20	0.022	0.026				S			Green siltstone near deposit.
82	20-44-75								R	U	
83	22-44-75								M	G	
84	28-44-75								R	U	
85	28-44-75	TW-2	0.029	0.18	0.47	0.54		C	M	U	
		TW-73	2.4	2.61	1.48	3.60		S			
86	28-44-75								M	G	
87	32-44-76								R	U	
88	4-43-75	LW-26	0.021	0.015	0.05			S	R	G	Coal below sandstone.
89	3-43-75								R	U	
90	12-44-78	AEC-25399	0.153	0.153	0.20			S	M	A	
91	28-43-75								R	U	
92	28-43-75								M	U	
93	28-43-75	AEC-25302	0.527	0.876	0.62			S	M	G	
94	29-43-75								R	U	
95	30-43-76								M	G	
96	30-43-76								M	G	
97	3-42-75								R	U	
98	23-42-75								R	U	
99	21-42-75	TW-74	0.034	0.006	0.03	0.04		C	M	U	
		AEC-1079	0.136	0.123	0.10			S			
100	1-44-76								R	A	
101	1-44-76								R	A	
102	20-45-75								M	A	
103	8-45-76	TW-69	0.048	0.045	0.24	0.17		C	M	G	Coal near siltstone.
		AEC-173	0.31	0.54							
				0.633	1.05		2.2 CaO				
104	21-45-76								M	G	

Table 1.--Localities of known uranium mineralization or anomalous high radioactivity, Pumpkin Buttes area, Wyoming--Continued

Loc. No.	Location 1/	Field Sample No.	Equivalent Uranium (percent)	Uranium (percent)	V_2O_5 (percent)	Mn (percent)	Other (percent)	2/	3/	4/	Remarks
105	17 + 20-46-74								R	A	
106	17-45-74	TW-102	3.4	4.60	2.28	0.305		S	M	A	
107	13-44-77								M	G	
108	13-44-77	TW-36	0.073	0.016	0.09	0.378		S	M	G	
109	24-44-77								R	G	
110	28-47-74	TW-77	0.020	0.007	0.67	0.09			M	A	
111	9 + 10-43-77	AEC-25396	0.323	0.519	0.69			S	M	U	
112	20-43-77	TW-13	0.091	0.064	0.98	0.83		S	R	U	Ironstone.
		TW-75	0.10	0.073	0.26	0.92		S			
113	20-43-77	TW-12	0.044	0.031	0.22	0.60		S	R	U	Ironstone.
114	20-43-77								R	U	Ironstone.
115	16-43-77	TW-11	0.29	0.49	0.51	0.07		S	M	U	
116	8-43-77								R	U	Ironstone.
117	5-42-76	LW-90	0.052	0.081	0.17	0.03		S	R	G	Carbonaceous shale below sandstone.
118	12-42-78	LW-16	0.001	0.003				S			Coal near siltstone.
		LW-17	0.10	0.062				S	M	U	Red baked siltstone.
		LW-71	0.12	0.10	0.08			S			Brown baked siltstone.
119	36-43-76	LW-114	0.014	0.008	0.42	20.48		S	M	G	Manganese concretion.
		LW-115	4.8	5.33	0.66	2.05		S			
		LW-116	0.025	0.018	0.07	0.17		C			1 ft. samples near base of sandstone.
		LW-117	0.012	0.003	0.05	1.18		C			1 ft. sample of manganiferous ss.
		LW-118	14.0	22.4	0.87	0.35		S			

Table 1.--Localities of known uranium mineralization or anomalous high radioactivity, Pumpkin Buttes area, Wyoming--Continued

Loc. No.	Location 1/	Field Sample No.	Equivalent Uranium (percent)	Uranium (percent)	V_2O_5 (percent)	Mn (percent)	Other (percent)	2/	3/	4/	Remarks
119	36-43-76	LW-119	0.088	0.084	0.05	0.08		C			3.2 ft. sample of light brown ss. near deposit.
		TW-43	0.033	0.020	0.35	17.9		S			Manganese nodule.
120	36-43-76								M	G	
121	25-43-76	LW-70	0.033	0.012	0.53			C	M	G	Green ss. at base of uranium-bearing sandstone.
122	33-44-76	LW-29	0.003	0.002	0.06			S	R	G	Samples taken at intervals along a hard ss. concretion about 140 ft. long.
		LW-30	0.019	0.003	0.17			S			
		LW-31	0.036	0.009	0.18			S			
		LW-32	0.014	0.003	0.05			S			
		LW-33	0.092	0.008	0.07			S			
		LW-34	0.027	0.003	0.20			S			
		LW-35	0.032	0.010	0.06			S			
		LW-36	0.007	0.006	0.07			S			
123	33-44-76	LW-28	0.020	0.022	0.13			S	R	G	Samples taken at intervals along a hard ss. concretion about 220 ft. long.
		LW-37	0.015	0.004	0.08			S			
		LW-38	0.10	0.053	0.24			S			
		LW-39	0.031	0.026	0.12			S			
		LW-40	0.029	0.004	0.12			S			
		LW-41	0.023	0.002	0.07			S			
		LW-42	0.015	0.004	0.19			S			
124	14-43-76	LW-43	0.007	0.002	0.12			C	R	U	
125	6-43-75	LW-65	0.013	0.006	0.06			C	R	U	
126	3-44-75								R	U	
127	30-42-75	TW-104	8.5	11.24	1.99	0.031		S	M	U	
128	35-42-77	TW-103	0.017	0.003	0.04	0.543		S	R	U	
129	23-41-77	TW-105	0.029	0.018	0.08	0.038	37.3 Fe_2O_3	S	M	U	Ironstone.

Table 1.--Localities of known uranium mineralization or anomalous high radioactivity, Pumpkin Buttes area, Wyoming--Continued

Loc. No.	Location 1/	Field Sample No.	Equivalent Uranium (percent)	Uranium (percent)	V_2O_5 (percent)	Mn (percent)	Other (percent)	2/	3/	4/	Remarks
130	7-44-75	TW-125	0.44	0.07	0.14	0.553		S	M	A	
		AEC-1066	0.306	0.026	0.05			S			
131	1-42-76								R	A	
132	29-43-75								M	A	
133	23-43-76	LW-106	0.036	0.009	0.1	0.02		S	R	U	Soil sample.
134	34-43-76								M	A	
135	34-43-76								M	A	
136	34-43-76								M	A	
137	26-43-76								M	A	
138	14-43-76								M	A	
139	4-42-76	AEC-25313	0.068	0.043	0.03		32.8 $CaCO_3$		M	A	
140	20-42-76	AEC-25316									
		and 25317	0.332	0.51	0.32			S	M		
141	28-42-76	AEC-25314	0.017	0.02	0.05			S	R	A	Base of sandstone.
142	15-42-76								M	A	
143	4-42-75								R	A	
144	34-43-75								R	A	
145	34-43-75								R	A	
146	34-43-75								R	A	
147	33-44-76	AEC-1067	1.207	1.632	1.67			S	M	A	
		TW-121	0.23	0.40	0.76	0.169		S			
148	28-44-76	AEC-1073	0.051	0.034	0.12				R	A	
149	34-43-75								R	A	
150	36-43-76	LW-99	0.64	0.66	2.71	6.5	5.93 CO_2	C	M	G	
151	4-42-76	LW-89	0.12	0.15	0.1	1.4		S	M	G	
152	36-45-76								M	U	
153	34-45-76								M	G	
154	6-43-74								R	U	
155	25-41-77								R	U	Ironstone.

Table 1.--Localities of known uranium mineralization or anomalous high radioactivity, Pumpkin Buttes area, Wyoming--Continued

Loc. No.	Location 1/	Field Sample No.	Equivalent Uranium (percent)	Uranium (percent)	V_2O_5 (percent)	Mn (percent)	Other (percent)	2/	3/	4/	Remarks
156	8-43-77								R	U	Ironstone.
157	5-43-77	TW-99	0.12	0.08	0.18	0.335	43.88 Fe_2O_3	S	M	U	Ironstone.
158	12-42-76	LW-91	0.058	0.063	0.21	0.11		C	M	G	2 ft. sample.
		LW-92	0.27	0.43	0.72	0.13		C			
		LW-93	0.16	0.16	0.75	0.03		C			5 ft. sample.
		LW-94	0.10	0.16	0.10	0.06		C			Basal 2 ft. sandstone.
		LW-95	1.3	0.73	0.75	0.13		C			3 ft. samples across deposit.
		LW-96	2.8	1.68	0.1	0.05		S			
159	12-42-76								M	G	
160	13-43-76								M	G	
161	8-43-76								R	U	
162	14-41-77								R	U	Ironstone.
163	23-41-75								R	U	
164	5-43-77	TW-100	0.057	0.028	0.05	0.785	34.00 Fe_2O_3	S	R	G	Ironstone.
165	5-43-75	TW-101	0.008	0.000	0.04	0.134		S	R	G	
166	4-43-75	TW-119	0.22	0.010	0.05	0.628		C	M	U	Host sandstone.
		LW-25	0.051	0.004	0.04			S			
167	11-45-75								M	U	
168	11-45-75	TW-108	0.009	0.001	0.03	0.029		C	M	G	Auger hole sample.
		TW-109	0.74	0.84	0.35	0.445		S			
169	6-43-74	AEC-1085	0.06	0.068	0.10				M	A	
170	6-43-74								R	A	
171	12-42-75	AEC-?	0.017	0.03					R	A	
172	12-42-75								R	A	
173	3-43-75								M	G	
174	16-45-74	AEC-25380	0.43	0.45	0.37			S	M	A	

Table 1.--Localities of known uranium mineralization or anomalous high radioactivity, Pumpkin Buttes area, Wyoming--Continued

Loc. No.	Location 1/	Field Sample No.	Equivalent Uranium (percent)	Uranium (percent)	V_2O_5 (percent)	Mn (percent)	Other (percent)	2/	3/	4/	Remarks
175	16-45-74	AEC-25384	0.15	0.111	0.13			S	M	A	
176	16-42-75	AEC-1080	0.01	tr.	0.03				M	A	
			1.05	1.01	0.47			S			
177	29-42-75	AEC-1065	0.05	0.008	0.03				M	A	
178	29-42-75	AEC-1068	1.37	1.95	1.42			S	M	A	
			3.21	4.87	2.39			S			
179	28-44-76								R	G	
180	23-44-76								R	G	
181	21-42-75								R	A	
182	14-44-77								R	G	
183	14-44-77								R	G	
184	14-44-77								R	G	
185	23-42-77								R	A	
186	8-43-77								R	A	
187	35-42-77								R	A	
188	25-45-76								R	A	
189	5-41-76	AEC-25401	0.026	0.009	tr.			S	R	A	
190	12-42-75	AEC-25402	0.02	0.10	tr.			S	R	A	
191	8-41-75	AEC-25400	0.009	tr.	0.06			S	R	A	
192	11-44-75								M	A	
193	8-43-77								R	A	
194	1-44-76								M	A	
195	10-44-75								R	A	
196	10-44-75								R	A	
197	2-44-75								R	G	
198	12-44-77								R	G	
199	9-43-77								R	A	
200	32-43-75								R	U	
201	32-43-75								R	U	

Table 1.--Localities of known uranium mineralization or anomalous high radioactivity, Pumpkin Buttes area, Wyoming--Continued

Loc. No.	Location 1/	Field Sample No.	Equivalent Uranium (percent)	Uranium (percent)	V_2O_5 (percent)	Mn (percent)	Other (percent)	2/	3/	4/	Remarks
202	29-43-75								R	U	
203	25-43-75								R	A	
204	29-41-75								M	G	
205	28-43-75								R	G	
206	28-43-75								R	G	
207	28-43-75								R	G	
208	16-43-77								R	A	
209	3-43-77								R	A	
210	17-43-77								R	A	
211	8-43-77								R	A	

1/ See figure 3.
2/ Type of sample: C - channel; S - selected.
3/ R - Locality of high radioactivity but no uranium minerals observed.
M - Locality of known uranium mineralization.
4/ Locality discovered by:
A - A.E.C. plane
U - U.S.G.S. plane
G - U.S.G.S. ground party

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