Some uranium occurrences in west Texas

By D. Hoye Eargle

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SOME URANIUM OCCURRENCES IN WEST TEXAS*

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D. Hoye Eargle

January 1956

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SOME URANIUM OCCURRENCES IN WEST TEXAS

By D. Hoye Eargle

ABSTRACT

Uranium minerals have been found at several localities in west Texas. In the King Mountain area in southwestern Upton County carnotite forms coatings along joint planes and in borings in marine Cretaceous limestone. In the Hueco Mountains area in El Paso and Hudspeth Counties carnotite and similar secondary uranium minerals form coatings in caliche and colluvium of Pleistocene(?) or Recent age, and along joints and bedding planes in Permian limestone. No uranium ore has been produced, however, from either area.

In the King Mountain area, coatings of carnotite and tyuyamunite have been observed from about 2 feet to a maximum of 7½ feet below the surface of the ground in the Edwards limestone of Early Cretaceous age. One channel sample of the limestone in this area contained 0.002 percent U and 0.004 percent eU, and a small, selected sample of the mineral coatings contained 8.52 percent U and an estimated 3.7 percent eU. In the Hueco Mountains area, coatings of carnotite and tyuyamunite have been found on boulders in colluvial deposits, on fractures in a caliche matrix of the colluvium, and on joints and bedding planes in the underlying Hueco limestone of Permian age. In the colluvium, the coatings have been found to depths of 20 feet below the surface, and in the Hueco limestone they extend to depths of 12 to 15 feet below the surface, maximum depths penetrated by the prospect pits. Selected samples from the colluvial deposits contained as much as 0.01 percent eU and 0.023 percent U. Uranium minerals are reported in other widely scattered prospect pits

along the west side of the Hueco Mountains.

In both areas the minerals seem to have been deposited by ground water and are found in a zone generally less than 20 feet below the surface of the ground. Analyses show that in both areas the uranium is out of equilibrium with its decomposition products; the fact that normally uranium is greater than equivalent uranium suggests that the mineralization is relatively recent.

INTRODUCTION

Several localities where uranium minerals were recently discovered in west Texas have been visited by the author and five of these were investigated in some detail -- two on a spur of King Mountain near McCamey, Upton County, and three in the Hueco Mountains along the line between Hudspeth and El Paso Counties (fig. 1). A few other areas in west Texas having anomalous radioactivity were reported by Hadfield (1953).

The investigation of these uranium localities was made by the U. S. Geological Survey on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission. The Bureau of Economic Geology, the University of Texas, provided office space and use of their library for this investigation. The author was assisted in the field by J. Stewart Hollingsworth. The author is indebted to Howard W. Broadrick who reported the discovery of the King Mountain deposit; to Richard A. Kennedy of El Paso, Tex., who reported the Hueco Mountains deposits; and to R. C. Sparks and J. R. Davis, ranchers in the Hueco Mountains area, who were very cooperative in facilitating the work of this survey.

Radiometric and chemical analyses and mineralogical determinations were made by the Geological Survey laboratories in Denver, Colorado,

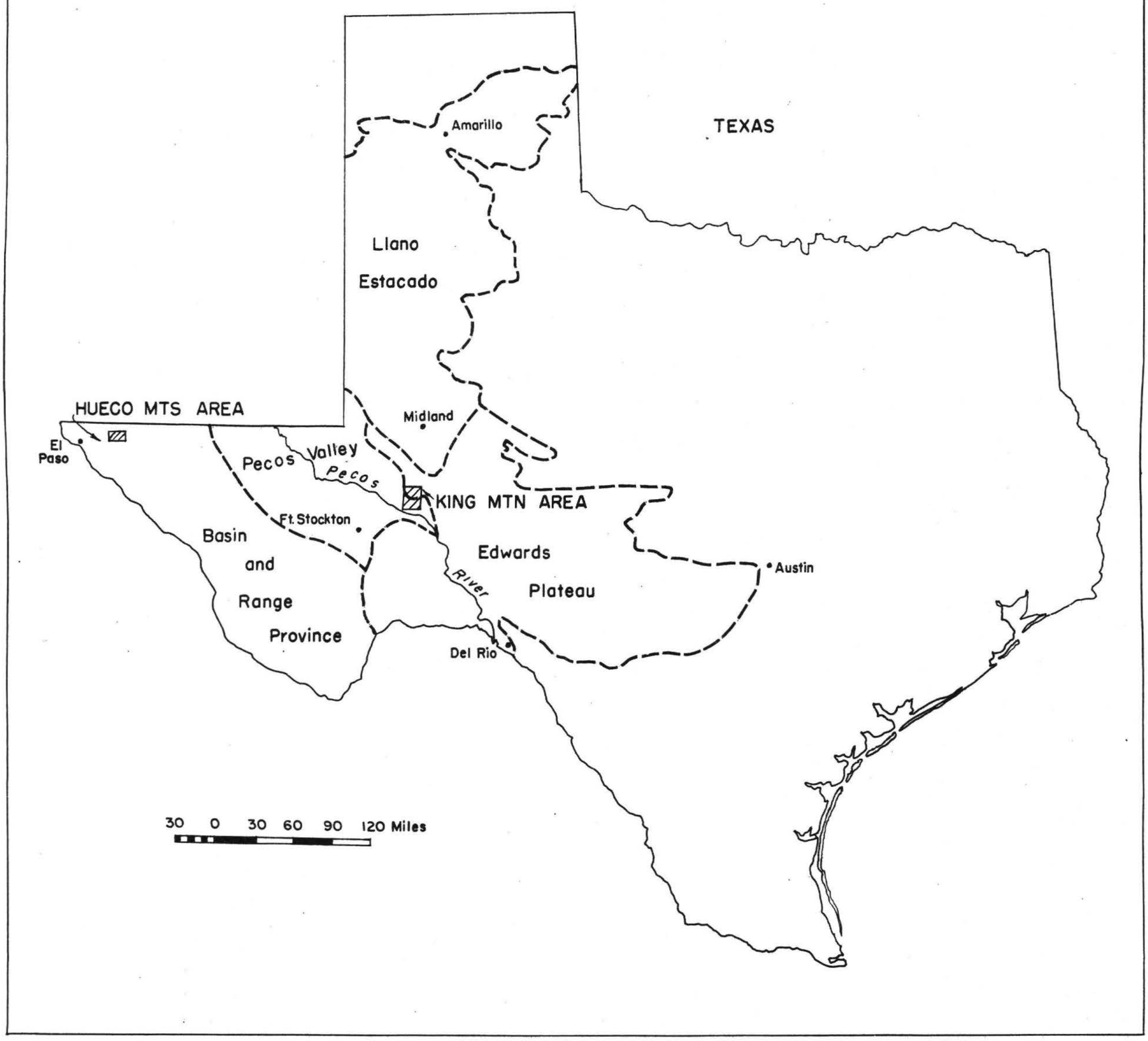

FIGURE I. INDEX MAP OF TEXAS SHOWING PHYSIOGRAPHIC PROVINCES IN VICINITY OF THE URANIUM LOCALITIES IN WEST TEXAS.

and in Washington, D. C.

KING MOUNTAIN AREA

Location and discovery

In January, 1954, Howard W. Broadrick of Monahans, Tex., and W. M. Taylor of Odessa, Tex. found uranium minerals coating rocks on a spur of King Mountain, about two miles north of McCamey, Tex., (fig. 2). The minerals were found in two pits -- one at the C. W. Brown No. 6 Della Bowen oil well where limestone blocks were bulldozed from the soil and the weathered limestone surface in digging a slush pit; and the other 0.2 mile farther southwest in a pit about ten feet deep that was blasted in limestone. The latter pit is located about half a mile northeast of a conspicuous radio tower. Both pits are accessible by auto from McCamey.

The author visited the area in company with Mr. Broadrick on June 12, 1954, and the radioactivity of the two pits was tested, a reconnaissance survey of the soil-covered surface of the mesa was made, and samples were collected for analysis. The locality was later studied in more detail and additional samples were collected.

Geology

The King Mountain area is at the western edge of the Edwards Plateau, a rolling, deeply-incised plateau held up by limestone of Early Cretaceous age (fig. 1). High mesas in the vicinity of the Pecos River in southwestern Upton County (fig. 2) are capped with thick limestone of the Lower Cretaceous Washita group, but limestones of the underlying Fredericksburg group hold up lower benches and form isolated mesas throughout the area.

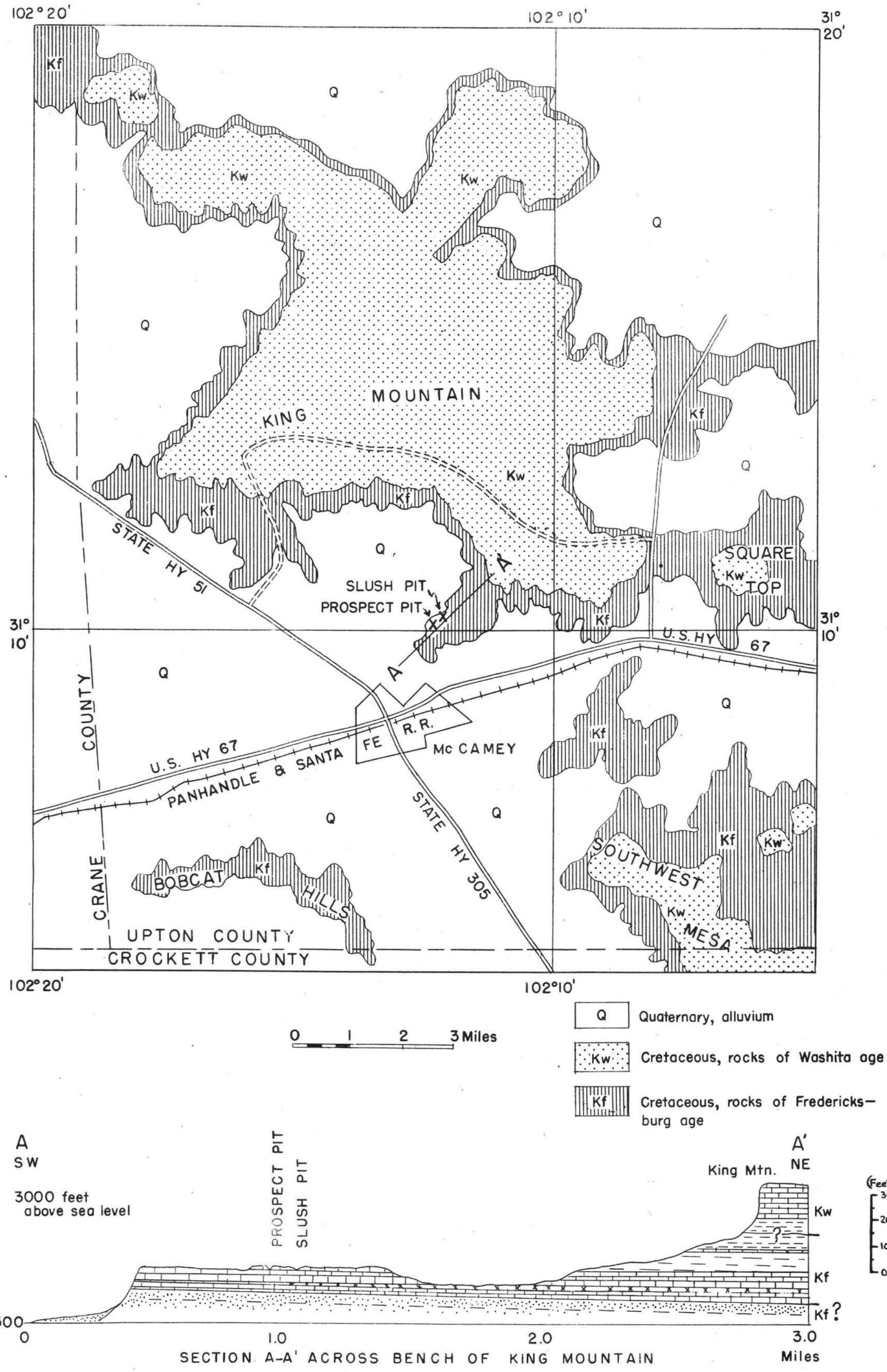

FIGURE 2—. GENERALIZED GEOLOGIC MAP OF KING MOUNTAIN AREA, UPTON COUNTY, TEXAS, SHOWING CARNOTITE PROSPECTS.

The Lower Cretaceous sedimentary rocks of the King Mountain area are chiefly marine. They include (fig. 3), from oldest to youngest, a basal Cretaceous sandstone of possible Fredericksburg age, about 60 feet thick, the Comanche Peak and Edwards formations, undifferentiated, about 170 feet thick, and the Kiamichi clay, about 90 feet thick, of Fredericksburg age; all are overlain by rocks of the Washita group, of which about 190 feet are exposed in this area. The uranium minerals are near the top of the undifferentiated Comanche Peak and Edwards formations.

Uranium prospects

Slush pit

The limestone in which the carnotite was found at the slush pit for the C. W. Brown No. 6 Della Bowen oil well is near the top of the predominantly limestone part of the Comanche Peak and Edwards formations, undifferentiated. The limestone is olive gray to pale yellowish brown, somewhat ferruginous, and slightly argillaceous and is composed of foraminiferal and algal material, as well as shells and fragments of shells. About 10 to 20 percent of the rock is occupied by conspicuous borings or tubular cavities, each 2½ to 4 cm. in diameter, that are filled with porous ferruginous residues of weathered material and a few fossil fragments. The uranium minerals form crusts on joint planes and segregations in the ferruginous residue that fills weathered cavities in the limestone.

Carnotite, tyuyamunite, and metatyuyamunite form a greenish-yellow film on the joint planes either in patches a few centimeters across or, in some places, coating almost the entire surface of a joint plane. In the cavities, the uranium minerals fill interstices or coat

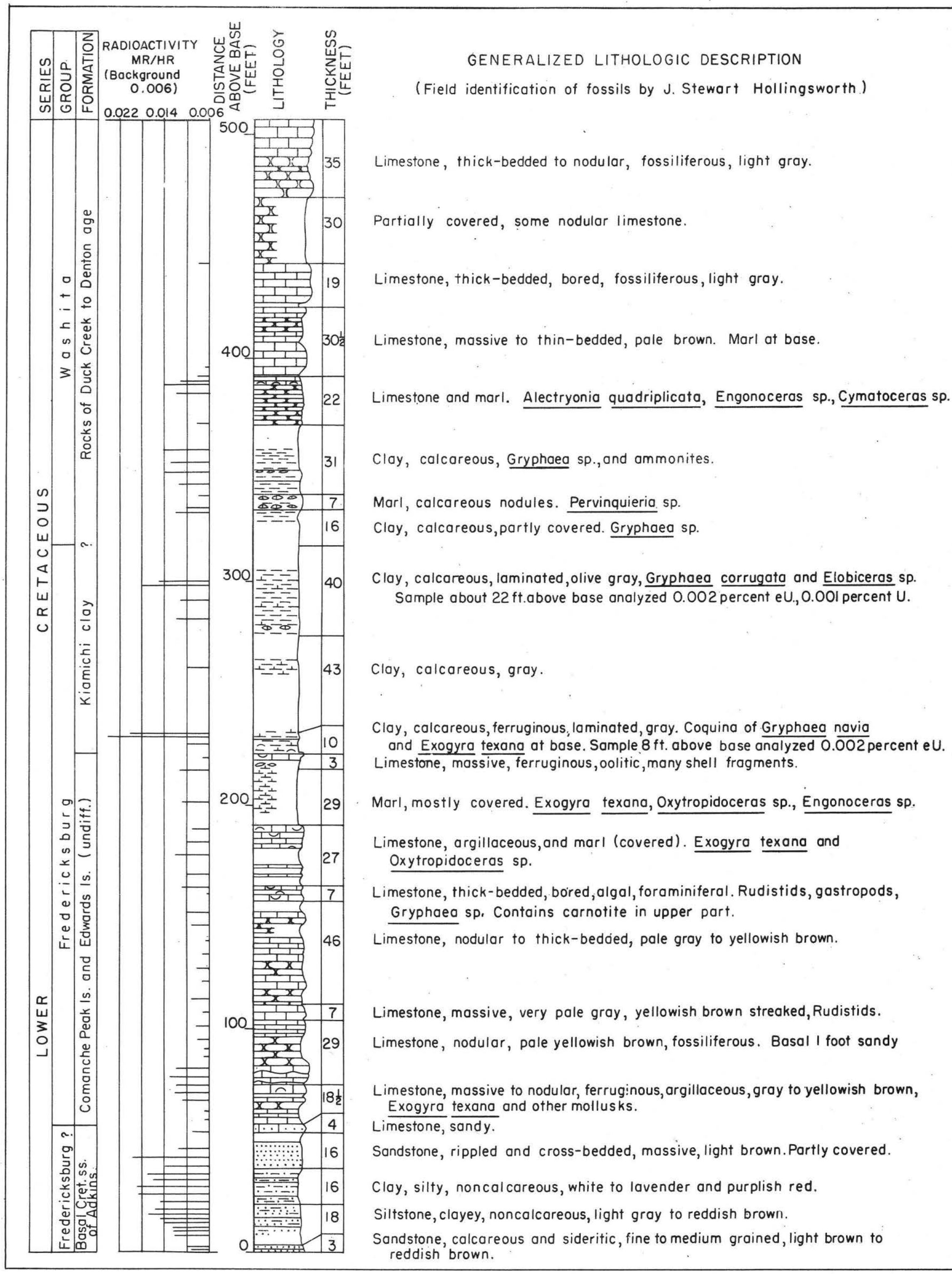

FIGURE 3.–STRATIGRAPHIC SECTION IN KING MOUNTAIN AREA.

cracks in the ferruginous residue.

Most of the limestone blocks in which the minerals were found were apparently from about 2 to 3 feet below the surface. The total depth of mineralization here, however, is not known, as the depth of the pit was reported to be only 3½ feet. Uranium minerals are rare or absent on the less-weathered limestone blocks that presumably came from the bottom of the pit and show little mineralization. As the minerals are apparently confined to the rocks near the surface and to the somewhat more weathered rocks, as indicated by the ferruginous residue, abundant solution cavities, and closely spaced jointing in the mineralized rock, the uranium probably was carried by and precipitated out of surface water or near-surface ground water.

A representative sample (ET-37, table 1) of weathered limestone, having a thin coating of carnotite, was analyzed for radioactivity and showed only 0.003 percent eU. However, a selected small sample (ET-37A, table 1) of ferruginous weathered limestone coated with carnotite contained 8.52 percent U.

Prospect pit

Secondary uranium minerals, of which only tyuyamunite has been identified, coat joint surfaces of limestone to a maximum observed depth of 7.5 feet below the surface in a small prospect pit about 0.2 mile southwest of the slush pit. The two pits appear to be at the same stratigraphic position.

The degree of mineralization in this pit is related to jointing, to depth below the surface, to degree of weathering, and to the lithology of the rock. The major jointing trends west, and a secondary set trends

Table 1.--Analyses of samples from the King Mountain area

Sample No.	Laboratory No.	Type of Sample[1]	Location	Material	Formation	eU (percent)	U (percent)	Other
ET-36A	210152	C	Prospect pit, 5½ ft below surface	Limestone	Edwards ls.	<0.001	(2)	
ET-36B	210153	C	Prospect pit, 5 ft below surface	Limestone	Edwards ls.	0.002	-	
ET-36C	210154	C	Prospect pit, 3½ ft below surface	Limestone	Edwards ls.	0.004	0.002	
ET-36D	210155	C	Prospect pit, 3 ft below surface	Limestone	Edwards ls.	0.001	-	
ET-37	210156	G	Slush pit, 2½ ± ft below surface	Limestone	Edwards ls.	0.003	-	
ET-37A	213012	S	Slush pit, 2 ± ft below surface	Residue of weathered ls. containing U minerals	Edwards ls.	3.7[3]	8.52	
ET-37B	213013	S	Slush pit, 2 ± ft below surface	do.	Edwards ls.	-	-	20 ppm Cu[4] 20 ppm Zn 400 ppm Pb
ET-37C	213014	S	Slush pit, 2.5± ft below surface	Unweathered ls.	Edwards ls.	-	-	<10 ppm Cu 20 ppm Zn 400 ppm Pb
ET-63A	213015	C	5.7 mi. ENE McCamey, E slope King Mountain	Clay	Kiamichi clay about 75 ft. above base	0.002	0.001	
ET-68	138472	C	4 mi. NW McCamey, SW slope King Mountain	do.	Kiamichi clay 8 ft. above base	0.002	-	

Analysts: S. Furman, J. H. Goode, J. Schuch, J. Wahlberg, and J. Wilson, U. S. Geological Survey

[1]C - channel; G - grab; S - selected

[2]Not analyzed chemically

[3]Insufficient sample for accurate routine analysis

[4]Geochemical prospecting analysis, H. E. Crowe, analyst, U. S. Geological Survey

N. 5° to 10° W. Other less well-defined trends are N. 55° W., N. 35° W., and a poorly-defined one N. 25° E. The best defined joints dip generally 70° NE to vertical. Coating of joint planes with tyuyamunite is most distinct on the west-trending joints, and next most distinct on those N. 5-10° W. Only traces of minerals were found on the other less well-defined joint sets.

Uranium minerals were found only below the 2.2-feet thick soil and calichified sub-soil zone. The greatest concentration of the yellow uranium minerals, associated with secondary calcareous and ferruginous material, is from 2.2 to 5.0 feet below the surface where weathering has formed more space along the joint planes in more porous limestone; as much as 30 to 40 percent of the surfaces of some of these joints is coated with uranium minerals. Below 5.0 feet to 7.5 feet, the maximum observed depth of mineralization, the joints in the more massive, fine-grained limestone are relatively tight and only traces of uranium minerals are present. Small black dendrites, probably manganese oxide, are also present on the joint surfaces and in places extend a few inches into the limestone.

Four grab samples (table 1) of the limestone with coatings of the uranium mineral were chosen for radiometric and chemical uranium analysis at intervals from 3.0 to 5.5 feet below the surface in the prospect pit. One sample from 3.5 feet depth analyzed 0.004 percent eU and 0.002 percent U. The remaining samples showed from 0.001 to 0.002 percent eU, but no chemical analyses of them were made.

General radioactivity and potential of the King Mountain area

Several scintillation-counter traverses were made across the top of the mesa on which uranium was found. One traverse extended for about 2,700 feet in a northeasterly direction from the vicinity of the prospect pit, and another across the mesa in a southeasterly direction from the vicinity of the slush pit. In general, the highest radioactivity was observed in the southwestern quarter of the mesa, but several relatively high zones were found near the center of the mesa. The highest radioactivity measured was in general near the pits where the carnotite had been exposed, but the other peaks may indicate concentrations of uranium minerals. The highest radioactivity measured on these traverses is nearly $2\frac{1}{2}$ times background, but the general average of all the measurements, taken at 100-foot intervals and closer in some places, is about twice background. The soil-covered surface of the mesa showed considerably higher radiation than the flanks of the mesa, where mostly bare limestone was exposed. The traverses indicate that the source of radiation is on, or just beneath, the almost flat surface of the mesa.

The Kiamichi clay overlying the Edwards limestone is slightly radioactive, but samples (ET-63A and ET-68) of the gray clay contained 0.001 percent U or less.

THE HUECO MOUNTAINS AREA

The Hueco Mountains (fig. 4) lie about 35 miles east of El Paso, Tex., at the western tip of the State. Rising in southeastern New Mexico, they extend southward about 25 miles into Texas astride the line between

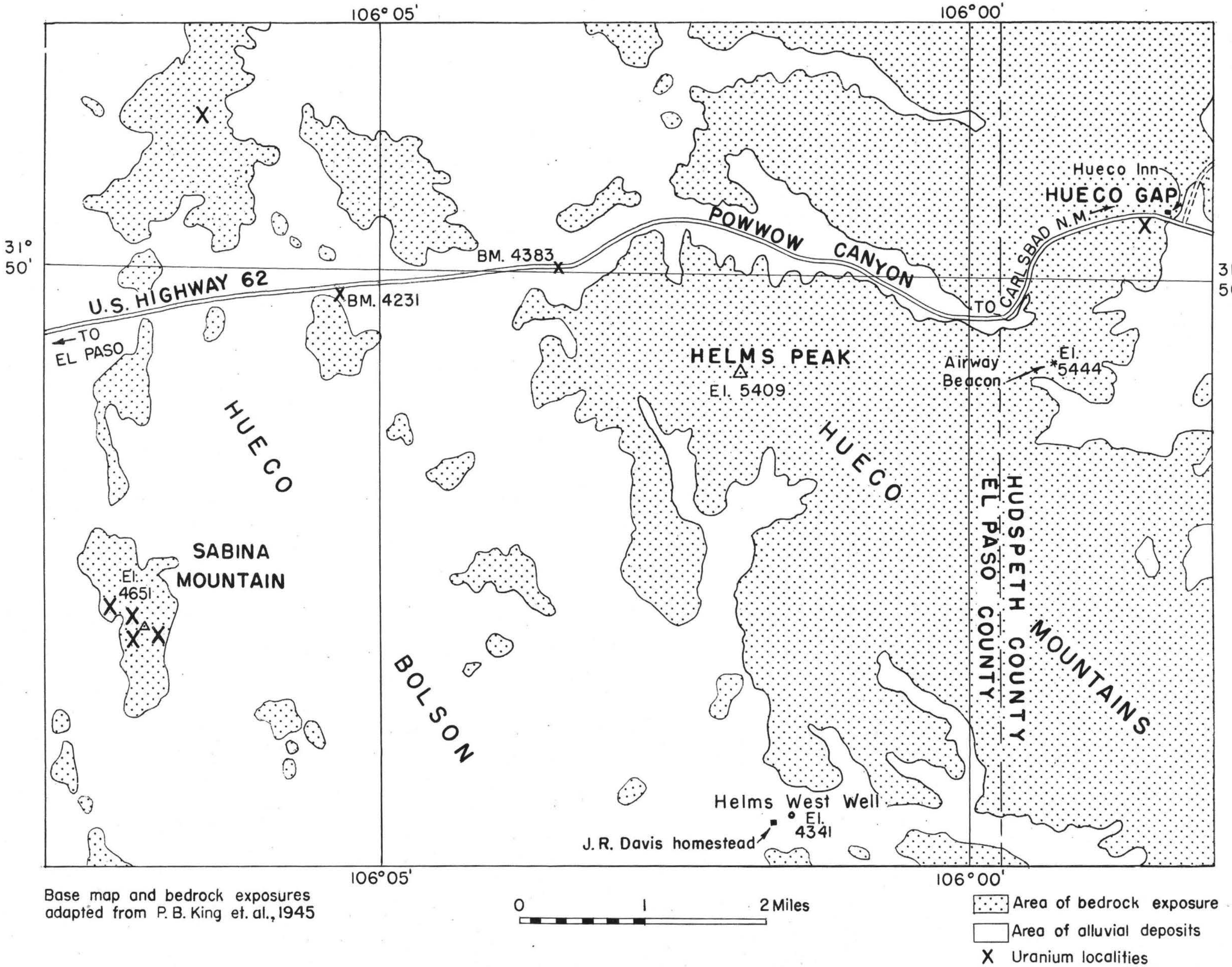

FIGURE 4 –. MAP OF PART OF HUECO MOUNTAINS, EL PASO AND HUDSPETH COUNTIES, TEXAS, SHOWING URANIUM LOCALITIES

El Paso and Hudspeth Counties. They are barren mountains that are about 1,000 feet above Hueco Bolson on the west, a low desert basin of alluvial deposits covered with drifted sand. On the east they are a dissected slope extending to the Diablo Plateau.

Several peaks and ridges that are parts of tilted fault blocks lie west of the main mountain mass and are entirely surrounded by bolson or fan deposits. One of these isolated ridges, about a mile long and locally called Sabina Mountain, lies from 2 to 3 miles south of U. S. Highway 62, five miles west of Helms West well at the foot of the Hueco Mountains. Carnotite has been found in calichified talus or colluvium and in the limestone bedrock on the flanks of this mountain.

Geology

The main body of the Hueco Mountains consists of Paleozoic rocks, chiefly limestone, gently domed and broken by a few faults. These rocks lie on Precambrian red granite, exposed only in the southern part of the mountains. Most systems of the Paleozoic are represented in the area (table 2). Cutting the Paleozoic and older rocks in the northern part of the Hueco Mountains, are masses of igneous rocks probably of Tertiary age, consisting of syenite porphyries and trachyte. For a fuller discussion of the stratigraphy of the area the reader is referred to a report by P. B. King in King and others (1945).

Remnants of deposits of an old colluvium, in part cemented by caliche, and Recent slope deposits of only slightly cemented erosional debris are present on the mountain flanks. The carnotite minerals found in this area are in remnants of the older, caliche-cemented colluvium and in the limestone bedrock of the lower Permian Hueco limestone.

Table 2.--Stratigraphic units in the Hueco Mountains, Texas

(adapted from King, 1945)

AGE	FORMATION
Quaternary	(Unconsolidated deposits)
Tertiary	(Intrusive syenite porphyry and trachyte)
Permian or Pennsylvanian	Hueco limestone
Pennsylvanian	Magdalena limestone
Mississippian	Helms formation
Devonian	(Chert, shale, and limestone)
Silurian	Fusselman limestone
Ordovician	Montoya limestone El Paso limestone
Cambrian or Ordovician	Bliss sandstone
Precambrian	(Granite)

Hueco Gap

At Hueco Gap (fig. 4) uranium minerals are sparsely distributed in a road cut in a northfacing slope on U. S. Highway 62 a third of a mile west of Hueco Inn, about 30 miles east of El Paso, Tex. The highway cut is about 1,000 feet long and a maximum of 25 feet deep. Carnotite was found in a section about 250 feet long extending from the center toward the west end of the cut.

The uranium minerals at this locality were discovered by E. L. Greenleaf, Eunice, N. Mex.

Geology

The limestone bedrock in the area is in the lower division of the Hueco limestone, which is late Pennsylvanian or early Permian in age (P. B. King and others, 1945). Here the limestone is gray, fine-grained and breaks with a conchoidal fracture. The limestone contains a few shale interbeds as much as a foot thick and some chert nodules as much as 3 inches long. The formation here strikes approximately north and dips from 2° to 4° east. The limestone contains vertical joints, the surfaces of which are generally covered with caliche. No fossils were found at this locality.

The surface of the Hueco limestone here is pitted with sink holes and is, consequently, highly irregular. Colluvium and a reddish-brown clayey residuum resulting from weathering, both cemented with caliche, fill the sinks and contain boulders of limestone as large as 3 feet in diameter. The limestone itself is generally fresh a few inches away from the contact with the material that fills the sinks. Three poorly-defined layers of different types of material are present in the colluvium.

The lower layer consists of sub-rounded to sub-angular pebbles, surrounded by pinkish-brown and white caliche. It is somewhat more indurated than the layers above and has a maximum thickness of 5 feet. Lying above the basal bed is a bed of the largest boulders found in the deposit. This layer contains less caliche than the material above and below, and appears to lie in sharp contact on the bed below but grades into the material above. From this coarse boulder bed to the surface the boulders are smaller, averaging several inches in diameter. The upper beds of colluvium slope gently to the west and have been truncated by the present surface. The gently sloping surface of the crest of the gap seems to truncate both the colluvium and the limestone.

Lying on the pitted limestone surface that slopes sharply to the west, is a deposit of colluvium that, in the western part of the cut, has a maximum thickness of 25 feet. The colluvium consists chiefly of sub-rounded boulders as much as 3 feet in diameter in a matrix of nearly white to yellowish-brown caliche.

Distribution of uranium minerals

Carnotite and minor amounts of tyuyamunite coat boulders and fractures in the calichified colluvium and, to a lesser extent, joint surfaces of limestone bedrock from 10 to 25 feet below the surface of the ground. Illite also was identified with the uranium minerals and is probably a residuum from the weathering of the Hueco limestone. Zones of the mineral-coated material within the body of colluvium are as much as 20 feet long in places but average only 5 feet or less thick. Most are in the lower layers of the colluvium -- the coarse bouldery bed and the underlying less-indurated bed of caliche and pebbles. In the center of the cut uranium minerals are mostly in the jointed limestone just beneath the filled sinks. They seem to bear a direct relationship to depth below the surface and to the lower layers of the colluvium and sinkhole deposits. In addition to carnotite and generally associated with it, is manganese oxide, also coating cracks in the caliche and forming dendrites on the pebbles and boulders.

Radioactivity and uranium content

Scintillation-measurements of the radioactivity of the caliche, the bedrock, and the sinkhole fill were made in a number of places throughout the cut. The bedrock away from the carnotite-stained surfaces were essentially non-radioactive, but some of the shale interbeds in the limestone were slightly more radioactive, about 1½ times background. Readings along the surface of the ground above the deposit averaged about 1½ times background.

The radioactivity of the sink-filling material away from the mineralized zones averaged about twice background. The basal deposits of the colluvium averaged from 2 to 3 times background, but in the vicinity of the mineralized zone, readings as high as 4 times background were obtained. In the higher beds of caliche radioactivity measurements averaged only about background to 1½ times background, but mineralized zones showed as high as 3½ times background.

A selected sample (ET-70B) of indurated pink caliche containing fragments of limestone coated with carnotite, illite, secondary calcite, and manganese oxide contained 0.017 percent eU and 0.023 percent U (table 3). A channel sample (ET-70A) thought to be representative of the colluvium at the locality contained only 0.001 percent eU.

Table 3.--Analyses of samples from the Hueco Mountains area

Sample No.	Laboratory No.	Type of Sample[1]	Location	Material	Formation	eU (percent)	U (percent)	Other materials identified
ET-70	216222	G	1/3 mi. W of Hueco Inn, U.S. Hwy. 62	Caliche	Colluvium, Pleistocene? overlying Hueco ls.	0.006	0.006	Carnotite, minor tyuyamunite, MnO
ET-70A	138473	G	do.	Caliche, 10-15 ft. below surface	do.	.001	-	Do.
ET-70B	138474	S	do.	Caliche filling joint in limestone, 20-25 ft. below surface	do.	.017	.023	Carnotite, minor calcite, illite
ET-81A	138482	C	R.C. Sparks prospect pit and drift, E side Sabina Mt., 20 mi. E of El Paso	Shaly ls.; landslide block, bottom right of drift face	Hueco ls.	.001	-	
ET-81B	138483	C	do.	Colluvium, east base of drift face	Pleistocene?	<.001	-	
ET-81C	138484	C	do.	Colluvium, west base of drift face	do.	.002	-	

Analysts: R. P. Cox, J. H. Goode, W. F. Outerbridge, and A. Sweeney, U. S. Geological Survey

[1]C - channel; G - grab; S - selected

[2]Sample submitted by E. P. Beroni, U. S. Geological Survey

Table 3.--Analyses of samples from the Hueco Mountains area (Continued)

Sample No.	Laboratory No.	Type of Sample[1]	Location	Material	Formation	eU (percent)	U (percent)	Other materials identified
ET-81D	138485	C	Sparks prospect	Colluvium, center of drift face	Pleistocene?	.001	-	
ET-81E	138486	C	do.	Colluvium, west top of drift face	do.	<.001	-	
ET-81F	138487	C	do.	Shaly ls. landslide block, top right of drift face	Hueco ls.	.001	-	
ET-81G	138488	C	do.	Colluvium, top of drift face	Pleistocene?	.002	-	
ET-81H	138489	S	do.	Limestone blocks coated with carnotite, roof of drift	Hueco ls.	.014	.018	Carnotite, calcite
ET-81I	138490	G	do.	Colluvium, 3 ft. below surface, in pit	Pleistocene?	.002	-	
ET-81J	138491	C	do.	Ls.-bedrock footwall, drift face	Hueco ls.	<.001	-	
ET-91	139866	G	ROHK prospect, 1½ mi. N of U.S. Hwy. 62, 21½ mi. E of El Paso	Shale	Hueco ls.	.006	.010	
PB-55-15[2]	226389	G	do.	Carnotite-bearing shale	Hueco ls.	.015	.022	<0.1 percent V_2O_5

Sabina Mountain prospects

The Sabina Mountain prospects (fig. 4) are about 20 miles east of El Paso, Tex., and about 2½ miles south of U. S. Highway 62. They are on both the eastern and the western flanks of an elongate ridge, locally called Sabina Mountain, about a mile and a half long that projects about 500 feet above the alluvial deposits of the Hueco Bolson. This mountain may be identified on topographic maps of the area and the geologic map of P. B. King and others (1945) as having a spot elevation on its crest of 4,651 feet above sea level.

At the time of this investigation a drift, 21 feet long and a maximum of about 18 feet underground, angling into the hill beneath a landslide block, and several other adjacent pits in talus exposed carnotite-stained rocks on the east flank of Sabina Mountain. The prospects are on property owned by R. C. Sparks, Route 1, Box 449, Ysleta, Tex.

On the western side of the mountain similar carnotite-stained surficial rocks occur in prospect pits along a belt about half a mile long and 200 feet above the base of the slopes.

Geology

The bedrock of Sabina Mountain is the lower part of the Hueco limestone, but a small patch of the underlying Magdalena limestone is exposed near the northeast base of the mountain (King and others, 1945). The Hueco limestone in this mountain consists of cherty and slightly argillaceous limestone; the beds change locally along strike from thick-bedded to thin-bedded limestone containing thin partings of shale. Many of the beds contain abundant fusulinids and some brachiopods and horn corals. The rocks dip 10° to the west. A fault with apparently small throw cuts the Hueco limestone at the head of a small reentrant valley on the western flank of the mountain. It strikes slightly east of north and apparently lies along the axis of the valley. Cross faults of small throw can be traced across the mountain. One, with a throw of about 3 feet which crosses just north of the prospect pit on the eastern side of the mountain, showed only background radioactivity.

The talus in which the carnotite is found contains angular boulders, as much as several feet in diameter, and smaller pebbles commonly embedded in caliche. The landslide on the eastern flank of the mountain contains angular blocks chiefly of nodular chert and shale, broken and jointed, cemented with caliche, and in part coated with carnotite. Immediately beneath the talus is massive gray cherty limestone. The older talus deposits that contain caliche are cut through by drainage lines, but modern alluvial fan deposits are present farther down the slope. The fans converge near the base of the mountain to form an alluvial apron that covers the older colluvial deposits and merges with playa and bolson deposits at the foot of the mountain.

Distribution of uranium minerals

As at Hueco Gap, carnotite coats pebbles, boulders, and caliche in the prospect pits on the east flank of Sabina Mountain. The coatings are in some places as thick as several mm., and are closely associated with abundant secondary calcite, generally in a mammillary form. The uranium minerals are most abundant from 3 to 8 feet below the surface in an area about 50 by 200 feet, but were not observed more than 12 feet below the surface.

The carnotite on the western side of the mountain is found in the soil and talus at a depth as shallow as two feet beneath the surface of the ground, but its most conspicuous showing is as coatings along joint planes and cracks and along bedding planes in the somewhat argillaceous limestone below. Modern alluvial fans cover the older talus and the bedrock downhill from the prospect pits. The carnotite stains are on rocks approximately at the same stratigraphic position in the Hueco limestone as the beds covered by the colluvium on the east flank of the mountain but, because of the dip to the west, are at a lower elevation. The area in which the carnotite has been found to date is about half a mile long and about 100 feet wide.

Radioactivity and uranium content

Radioactivity within the drift on the east side of Sabina Mountain averaged about twice background, except along the roof where readings taken on the carnotite-covered boulders and on yellow clayey gouge along the roof of the drift were a maximum of four times background and averaged about three times. In other pits excavated in the area to about 3 feet below the surface, the readings averaged about twice to three times background. The surface showed little more than background. In the pits on the west side of the mountain, the maximum scintillation-counter readings were about $3\frac{1}{2}$ times background, but on the bedrock exposures almost no readings higher than background were obtained.

Ten samples were chosen for laboratory analyses for radioactivity and uranium content from the prospect pits and the drift on the eastern side of Sabina Mountain (table 3). One block of limestone partially coated with carnotite from the roof of the drift contained 0.014 percent eU and 0.018 percent U. Grab samples of the talus from prospect pits and channel samples from the face and walls of the drift contained 0.002 percent eU or less. Chemical analyses were not made of these samples.

<u>Other localities in the Hueco Mountains area and vicinity</u>

Another uranium locality, on the R.O.H.K. claims, that was being prospected at the time of this brief survey is in a saddle in a ridge 1½ miles north of U. S. Highway 62, about 4½ miles north of the Sabina Mountain localities. There, as on the western slope of Sabina Mountain, the carnotite is in the soil about 2 to 3 feet below the surface and in joints and cracks in the argillaceous Hueco limestone and in interbedded slightly carbonaceous gray shale. Coatings of carnotite have been found to the total depth of a bulldozed pit 8 feet deep. This prospect was reported by R. A. Kennedy, who found a radioactive anomaly at this point. Samples of slightly carbonaceous gray shale that showed slight carnotite coating along joints and bedding planes from the R.O.H.K. claims averaged 0.006 percent eU, and as much as 0.022 percent U (table 3).

Several playas in the bolsons are also weakly radioactive. One is immediately east of Sabina Mountain into which water from Powwow Canyon drains. Another is east of the R.O.H.K. locality, and into this, flood water from a canyon north of Powwow Canyon drains. In each of these playas readings up to 4 times background were obtained by ground scintillation traverses.

Since this reconnaissance survey of the Hueco Mountains was made, other occurrences of uranium in the general area of the Sabina Mountain and R.O.H.K. claims have been reported to the author. They are apparently of the same type and are found in similar geologic conditions as those previously described.

As the Hueco limestone and the underlying Magdalena limestone consist mainly of impervious rock, they are not considered good host rocks for uranium deposits. In places along the unconformity between the two formations is the Powwow conglomerate member of the Hueco limestone which on surface exposures has good porosity. These beds might contain similar uranium occurrences.

An outcrop band of weakly radioactive gray shale of Devonian age crosses the Hueco Mountains from northwest to southeast. (See map of King and others, 1945.) It is found in outliers composed of folded and faulted rocks 3 miles and 5 miles southwest of Hueco Tanks. The main outcrop area, however, extends almost continuously as a very narrow band from one mile southeast of Helms Peak, southeastward for 13 miles to the foot of the Diablo Plateau. Four samples, collected from zones showing the most radioactivity in shallow pits 2.7 miles southeast of Helms Peak in the weathered shale, analyzed 0.005 percent eU and 0.003 percent U. A set of 5 channel samples were collected also from the Devonian shale near the head of the northern prong of Vinton Canyon in the Franklin Mountains 16 miles north of El Paso. These contained from 0.002 to 0.004 percent eU -- the sample containing 0.004 percent eU analyzing 0.001 percent U. Two samples of dark gray shale of the Magdalena formation (Pennsylvanian) from the same canyon contained 0.002 percent eU. The uranium in these shales was probably associated with the sediments when they were deposited.

A sample of glauconitic fine-grained sandstone and shale from a prospect pit in the Bliss sandstone 2.8 miles south-southeast of Helms West Well contained 0.003 percent eU and 0.001 percent U.

SOURCE OF THE URANIUM

The wide variety of materials in which most of the uranium is found in the King Mountain and Hueco Mountain areas and the obvious relation of the uranium concentrations with the modern ground surface indicates that the uranium has been leached by surface and ground waters from some nearby, perhaps formerly overlying, material and concentrated in its present position, perhaps by evaporation of the water.

Two possible sources of the uranium in the King Mountain area are: (1) the Ogallala formation of late Tertiary (Miocene or Pliocene) age, which probably once covered the area and which is known to contain small amounts of uranium in other areas, and (2) the slightly radioactive Kiamichi clay overlying the Edwards limestone. Evidence seems to favor the former, for although the Ogallala is not present in the immediate area now, in nearby areas to the north and east it still overlies beds of Fredericksburg age (Darton and others, 1937). If the Ogallala once extended over this area, the uranium might have been leached from it during erosion and later precipitated and concentrated in the Edwards limestone. To have the uranium derived and concentrated from the radioactive Kiamichi clay would require the uranium to have travelled downward more than 60 feet through relatively impermeable clay of considerably less radioactivity.

In the Hueco Mountain area, the deposits again seem to be related closely to the modern surface and to have been concentrated from water percolating downward from the surface. The ultimate source of the uranium is not known, but it may have been the nearby Tertiary(?) igneous rocks that have been and are being eroded, or possibly some radioactive sediments that once covered the area.

OTHER URANIUM LOCALITIES IN WEST TEXAS

Since this investigation was made, other uranium-bearing materials have also been reported, and subsequently visited, from several counties adjacent to the localities described here. Uranium minerals have been reported (E. P. Beroni, personal communication) from localities in Reagan, Glasscock, and Reeves Counties, apparently in caliche. The uranium concentrations are believed to be geologically similar to the King Mountain locality.

In the areas north and northwest of Lajitas in the Big Bend area of southwestern Brewster and southeastern Presidio Counties, uranium minerals have been found in folded and faulted limestones in the Devils River (Georgetown) limestone of Cretaceous age and in carbonaceous sandstones and conglomerates in the tuffaceous rocks of early Tertiary age.

One sample from a prospect in a mineralized zone on Tres Cuevas Mountain north of Lajitas and just east of the Presidio-Brewster county line contained 0.015 percent eU and 0.017 percent U.

A sample of radioactive calcareous tufa from Indian Hot Springs 26 miles airline south of Sierra Blanca, Hudspeth County, near the Rio Grande, contained 0.029 percent eU but less than 0.001 percent U. The radioactivity there is believed to be due to the presence of radium.

Several channel samples of coal from abandoned mines in the Eagle Ford shale of Late Cretaceous age in the Eagle Mountains about half a mile southwest of Eagle Spring, southeastern Hudspeth County, averaged 0.002 percent eU, and the ash from the coal contained an average of 0.004 percent U.

In northwestern Presidio County immediately west of Quinn Canyon, about 3 1/2 miles southwest of Gettysburg Peak, a mesa capped with rhyolitic welded tuff about 40 feet thick contains radial aggregates of uranophane crystals (identified by J. W. Adams, U. S. Geological Survey). Ten to 15 feet below the top of the mesa on a vertical scarp facing east, the uranophane was found in joints and in vesicles associated with fluorescent calcite and with fluorescent hyalite opal. The zone of greatest radioactivity, containing the uranium minerals, was reported to be about 5 feet thick and to extend for about 200 feet along the face of the cliff. Its extent into the mesa is unknown. Blisterlike mounds several feet high dot the surface of the flow; some of them show higher radioactivity than the remainder of the rock. A select sample of the rhyolite from a block of float, containing uranium mineral aggregates, analyzed 0.52 percent eU and 0.77 percent U.

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