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URANIUM IN EASTERN NEW MEXICO*

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ABSTRACT

Known uranium occurrences in eastern New Mexico are all small; total production of uranium ore is less than 50 tons and reserves are a few hundred tons. The most numerous and largest deposits are near the base of the middle fluviatile sandstone member of the Chinle Formation of Late Triassic age. Uranium deposits of ore grade occur in the Morrison, Chinle, Yates, and Sangre de Cristo Formations; uraniferous rock of sub-ore grade occurs in the Santa Rosa, Redonda, and Gatuna Formations, and in Pleistocene volcanic ash.

INTRODUCTION

The uranium boom of the early 1950's in the Colorado Plateau region extended into eastern New Mexico where the chief uranium-bearing rocks of the Plateau, the Morrison and Chinle Formations, cropped out extensively. The U.S. Atomic Energy Commission (1966) conducted reconnaissance airborne radiometric surveys over these formations in eastern New Mexico from 1953 through 1955 and detected many radioactive anomalies. During the 1950's prospectors located numerous claims covering uraniferous occurrences (Grand Junction Office, AEC, 1970). Some of the more promising deposits were explored by pits and short adits, and a few were drilled. Trial shipments of about 80 tons averaging about 0.05 percent U_3O_8 were sent to Grants, N. Mex., the nearest ore-buying station. A total of 38 tons of ore averaging 0.13 percent U_3O_8 was mined. All the known deposits are small, and the total reserves are a few hundred tons of uranium ore.

Renewed interest in uranium in 1966 led to exploration drilling in Triassic rocks by a dozen or so oil and mining companies, largely in Guadalupe, Quay, and San Miguel Counties but also in Chaves, Curry, Lea, and Roosevelt Counties. From 1966 through 1971, an estimated 250,000 feet of exploration drilling was done in eastern New Mexico. Although results of that exploration have not been released, it is apparent that any deposits found are too small to exploit under present economic conditions.

Anomalous occurrences of uranium have been reported in the Sangre de Cristo Formation of Pennsylvanian and Permian age; the Yates Formation of Permian age; the Santa Rosa, Chinle, Sheep Pen (of Baldwin and Muehlberger, 1959), and Redonda Formations of Late Triassic age; the Morrison Formation of Late Jurassic age; the Gatuna Formation of Pleistocene (?) age; and volcanic ash of Pleistocene age. Occurrences are most numerous in the Chinle Formation, and ore-grade rock occurs also in the Morrison, Yates, and Sangre de Cristo Formations. For the reader's convenience, reports on these deposits not referred to in the text, as well as reports on related deposits in Triassic rocks in nearby west Texas, are included under "Selected references."

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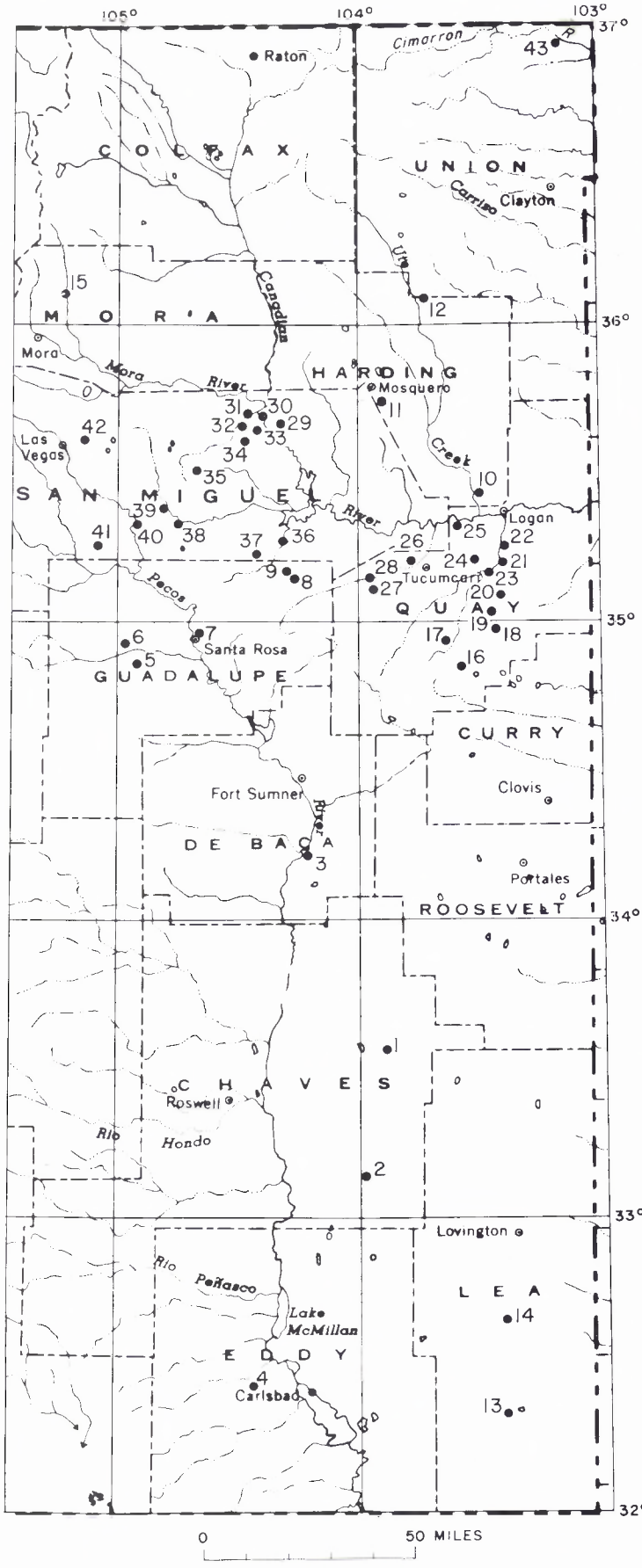
URANIUM IN SANGRE DE CRISTO FORMATION

Uranium-vanadium and copper deposits in the lower part of the Sangre de Cristo Formation (Pennsylvanian and Permian) in the Coyote district, Mora County, N. Mex. (fig. 1, locality 15), are described by Tschanz, Laub, and Fuller (1958). These authors divided the Sangre de Cristo into six generalized lithologic units: basal red arkose; transitional conglomerate, shale, and siltstone; fluviatile sandstone; red siltstone; variegated sandstone; and conglomerate sandstone. The uranium-vanadium ore-grade deposits are small closely spaced pockets associated with carbonized wood and hematite in the fluviatile sandstone unit, which is about in the middle of thy formation. Most of these pockets are less than 2 feet thick and 10 feet long. Uranium apparently is present chiefly in an unidentified black substance. Metatyuyamunite is common in the oxidized ores. Some of the copper deposits in the transitional beds and upper part of the basal red arkose contain small amounts of uranium, and a little occurs in gray shale below the copper deposits in the basal red arkose.

At the Continental Oil Leatherwood-Reed No. 1 well, about 35 miles south of the Coyote district in sec. 15, T. 16 N., R. 17 E., San Miguel County (fig. 1, locality 42), anomalous radioactivity is recorded from the Sangre de Cristo Formation and the Lane-Wells gamma-ray log between depths of about 2,855 and 2,885 feet. This anomaly was explored in 1968 with two holes drilled by the American Minerals Co., a subsidiary of Frontier Resources, Inc., of Denver. Analyses of samples taken from 1-foot intervals in the mineralized zone from these holes show from a few thousandths to nearly one-tenth of a percent of U_3O_8 (written commun., Frontier Resources, Inc., 1970). Uranium is associated with black organic material that impregnates micaceous fine-grained arkose in the lower part of the Sangre de Cristo Formation. The black asphaltite-like material occurs as thin irregular layers along bedding and as pellets about 2 mm in diameter. According to R. L. Erickson of the U.S. Geological Survey (written commun., 1970), the pellets consist of uraniferous asphaltite enclosing cores of clausthalite (PbSe), some of which contain flakes of native gold. Laser spectrographic analysis of the clausthalite showed 700 ppm Au, 70 ppm Ag, and abnormally large amounts of other metals.

URANIUM IN THE YATES FORMATION

Uranium occurs in dense light-gray dolomite of the Yates Formation of Permian age at the Rocky Arroyo prospect (locality 4) in the SE¼ sec. 26, T. 21 S., R. 24 E., Eddy County, N. Mex. (Waltman, 1954). Black uraniferous asphaltite-like organic matter occurs as millimeter-sized pellets, pockets as much as 10 cm across, and as coatings on fracture and bedding surfaces. Selected organic matter showed as much as 2.35 percent U_3O_8, but analyses of channel samples across the mineralized section ranged from only 0.017 to 0.139 per-



List of uranium localities shown on figure 1

County—Locality No.—Name	Sec.	T.	R.	Stratigraphic unit
Chaves County				
1. Hoffacker test hole	Approximate			Dockum, middle
2. Stoltz test hole	1	14S	29E	Dockum
DeBaca County				
3. Cebolo Creek	11	1S	26E	Chinle, lower?
Eddy County				
4. Rocky Arroyo	26	21S	24E	Yates
Guadalupe County				
5. American Uranium prospect	4	7N	19E	Santa Rosa, upper
6. Porcupine	13	8N	18E	Do.
7. Santa Rosa RR cut	2	8N	21E	Do.
8. Branch ranch	27	11N	25E	Chinle, middle
9. Neafus ranch	17	11N	25E	Do.
Harding County				
10. Acme	14	14N	32E	Volcanic ash, Pleistocene Chinle, middle
11. Polito no. 2	5?	17N	29E	Morrison?
12. Gallegher Bros. ranch	4	21N	30E	Morrison
Lea County				
13. Stoltz test hole	35	22S	34E	Dockum, basal
14. Moreland and Hooper	23,24	19S	35E	Gatuna
Mora County				
15. Coyote district	--	22N	16E	Sangre de Cristo
Quay County				
16. Good Luck group	6	7N	32E	Chinle, middle
17. Fife prospects	3	8N	31E	Redonda
18. Red Peak Mining Co.	28	9N	33E	Chinle, upper?
19. Wallace ranch, north	5	9N	33E	Chinle, middle?
20. Lucky Find no. 15	15	10N	33E	Do.
21. Little Rattler mine	12	11N	33E	Chinle, middle
22. Smith ranch	23	12N	33E	Do.
23. Gilstrap-Trusdel claim	29	11N	33E	Chinle, middle
Payne claim	18	11N	33E	Do.
24. Troutman ranch	2	11N	32E	Do.
25. AEC anomalies 1 and 2	25	13N	31E	Chinle, middle?
26. Strawn prospect	32	12N	30E	Morrison, middle?
Breen prospect	5	11N	30E	Do.
27. Richardson ranch	2	10N	28E	Morrison, upper
28. Bel Aro mine	24	11N	28E	Morrison, basal?
8 Point claims	15	11N	28E	Do.
San Miguel County				
29. El Villa claim	19	17N	25E	Chinle, middle
Lujan ranch, west	24,25	17N	24E	Do.
30. Cip Lujan	17	17N	24E	Chinle, lower, middle
Lujan ranch	8	17N	24E	Chinle, middle
Lujan Cattle Co.	16	17N	24E	Do.
31. Windy no. 9 mine	14	17N	23E	Do.
Key claims	1	17N	23E	Do.
32. Mikie V claims	27	17N	23E	Do.
AEC anomaly 3	28	17N	23E	Do.
33. Bish no. 2 mine	31	17N	24E	Chinle, lower, middle
Hunt Oil Co.	29	17N	24E	Chinle, middle
Sab	29	17N	24E	Do.
34. T claims	10?	16N	23E	Do.
35. Elov Estrado	24	15N	21E	Morrison
36. St. Anne claims	5	12N	25E	Chinle, middle
37. Bookout ranch	31	12N	24E	Chinle, lower
	25	12N	23E	Do.
38. East Point, Mesa Montosa	19	13N	21E	Do.
39. AEC anomaly 12	34	14N	20E	Do.
40. Park Springs ranch	27	13N	19E	Do.
41. Sowell ranch	24	12N	17E	Do.
42. Conoco Leatherwood-Reed No. 1 well	15	16N	17E	Sangre de Cristo
Union County				
43. Ft. Pitt Copper Co.	12	31N	35E	Plug in Sheep Pen

Figure 1. Index map of uranium localities in eastern New Mexico.

cent U_3O_8. The mineralized zone is about 3 feet thick and 5 feet across at the outcrop and has been explored 60 feet underground by an adit. Waltman noted that highly radioactive zones have been recorded on numerous gamma-ray logs of oil test holes through the Yates in the nearby region.

URANIUM IN THE DOCKUM GROUP

In eastern New Mexico, the Triassic Dockum Group consists of a variable group of formations. Formations in the Cimarron River valley in Union County differ markedly from those to the south in San Miguel and Harding Counties, and these differences suggest that the Sierra Grande arch, a broad northeast-trending positive structural feature, was active during Triassic time and influenced sedimentation. Uranium is very sparse north of the arch but widespread to the south, and therefore the possible influence of the arch on the localization of uranium seems worthy of study (U.S. Geol. Survey, 1970, p. A10).

The Baldy Hill, Travessor, Sloan Canyon, and Sheep Pen Formations of Baldwin and Muehlberger in the Cimarron River valley were prospected and tested by airborne scintillometers in 1955 with virtually negative results (Baldwin and Muehlberger, 1959, p. 91-92). Clastic plugs that intruded the Sheep Pen Sandstone at the close of the Triassic are variably mineralized with iron and copper, and a few are weakly radioactive. A sample of a recent accumulation of limy silt in a shallow pit at the workings of the Ft. Pitt copper deposit in sec. 12, T. 31 N., R. 35 E., contained 0.004 percent U_3O_8. The exposed Triassic formations in the valley appear to be unfavorable for uranium because of their dominant red color, lack of carbonaceous material, and sparsity of fluviatile sandstone.

In the broad outcrop area of Triassic rocks north of a latitude about 20 miles south of Ft. Sumner, the Dockum Group consists of the Santa Rosa Sandstone overlain by the Chinle Formation. In the Tucumcari area the Chinle is overlain by the Redonda Formation. Farther south of Ft. Sumner, outcrops are poor and sparse, and the Dockum appears to consist chiefly of shale of the Chinle. In this southern area, anomalous concentrations of uranium occur in the outcrop in DeBaca County and in several test holes in Chaves and Lea Counties (fig. 1). Most of the uranium deposits in the Dockum, however, are in the northern area, chiefly in Quay and San Miguel Counties.

Santa Rosa Sandstone

In western Guadalupe County, the Santa Rosa Sandstone is divisible into four informal members: lower sandstone member, middle sandstone member, shale member (locally absent), and upper sandstone member. These members were mapped in north-central Guadalupe County by Gorman and Robeck (1946). In the vicinity of the Guadalupe (Pastura) copper-mining district southwest of Santa Rosa, the three sandstone members are well developed, but the shale member is present only locally. The middle sandstone member appears to be the most continuous and prominent member and crops out over wide areas. It extends northward into San Miguel County and is exposed where State Highway 65 crosses the Canadian River south of Sabinosa (fig. 1, coincides with locality 30). Eastward in Quay County, a sandstone with lithology and bedding characteristics identical to those of the middle sandstone member crops out where State Highway 39 crosses the Canadian River and is mapped as Santa Rosa Sandstone by Dane and Bachman (1965). Anomalous radioactivity has been detected in the upper sandstone member at three localities in Guadalupe County.

Radioactive zones are present at several levels in brown fine-grained sandstone of the upper member at the American Uranium prospect in sec. 4, T. 7 N., R. 19 E. (locality 5), about 5 miles west of the Pastura copper mine. About 6 inches of radioactive yellowish-gray limonitic calcareous sandstone that contains 0.045 percent U_3O_8 is exposed in a small prospect pit. Several exploratory holes were drilled within 600 feet of the pit, and holes within 100 feet of the pit intersected thin uraniferous zones at depths of about 10, 65, and 85 feet.

In sec. 13, T. 8 N., R. 18 E., about 5 miles northwest of the American Uranium prospect, anomalous radioactivity is shown by a light-olive-gray sandy claystone near the base of the upper sandstone member. A grab sample contained 0.005 percent eU_3O_8.

In the railroad cut in sec. 2, T. 8 N., R. 21 E., at the northwest edge of Santa Rosa, an irregular claystone lens 0-3 feet thick and 400 feet long close to the base of the upper sandstone member is anomalously radioactive. A grab sample of gray calcareous carbonaceous claystone showed 0.004 percent eU_3O_8.

Chinle Formation

The Chinle Formation is divisible into three informal members: lower shale member, middle sandstone member, and upper shale member. These members were first recognized and described by Griggs and Hendrickson (1951, p. 26-27) in San Miguel County and were mapped in the Sabinoso uranium district, Harding, San Miguel, and Mora Counties, by Wanek (1962) and in the Gallinas Creek area northwest of Las Vegas, San Miguel County, by Baltz (1972). Uranium occurrences are widespread in the middle member; those in the lower member are concentrated chiefly in south-central San Miguel County; and a single occurrence in Quay County is probably in the upper member. Deposits in the lower and middle members are associated with grayish-green carbonaceous rocks, which are sparse in the upper member. This may account for the scarcity of uranium in the upper member.

In central San Miguel County, the lower shale member consists of slope-forming interbedded grayish-red and greenish-gray shaly claystone, siltstone, and very fine grained sandstone and minor ledges of light-brown fine-grained lenticular sandstone and thin limestone-pebble conglomerate. Greenish-gray rocks are present throughout, but are most abundant near the middle of the member. Uranium is associated with carbonized plant matter in greenish-gray shaly beds and in light-brown sandstone and associated conglomerate (localities 30, 33, 37-41). Many of the radioactive zones near the middle of the member are 5-15 feet thick and extend along strike for 1 foot to several hundred feet, and discontinuously for as much as a mile. Tyuyamunite from several localities has been identified by X-ray diffraction, and malachite and azurite are present in a few places. Uranium content is low, ranging from 0.003 to 0.02 percent U_3O_8. The only ore-grade material is found at AEC anomaly 12 at an abandoned copper mine (locality 39), where uranium is in a lens of gray micaceous calcareous carbonaceous fine-grained shaly sandstone near the middle of the member. Tyuyamunite, malachite, and azurite

occur chiefly with carbonized plant remains. One grab sample contained 0.11 percent $U_{33}O_8$ and 0.85 percent V_2O_5, and a chip sample contained 0.03 percent U_3O_8, 0.16 percent V_2O_5, and 3.40 percent Cu.

The middle sandstone member consists of one to several ledges of fluviatile sandstone and associated limestone-pebble conglomerate separated by variable thicknesses of shale. The sandstones are grayish red to pale reddish brown or locally light brown, and are calcareous, micaceous, and fine to medium grained. Carbonized wood fragments are found locally in light-brown sandstone and in greenish-gray clayey and limestone-pebbly zones at or near the base of the lowest ledge. Uranium is associated with these carbonaceous rocks, commonly where they fill scour channels cut into the underlying lower shale member. Uranium minerals are sparse, but in places tyuyamunite, commonly mixed with metatyuyamunite, is present. At the Branch ranch deposit (locality 8), uranophane and umohoite were also identified. Limonite is common and abundant is oxidized ores, and malachite occurs sparingly in a few deposits. Attempts to identify primary uranium minerals in black highly uraniferous material from two deposits has been unsuccessful, but such material probably contains amorphous UO_2. The primary ore probably consisted of uraninite and pyrite. Slightly over half of the deposits in the middle member have some material that contains more than 0.10 percent U_3O_8. The deposits consist of carbonaceous layers a few inches to over one foot thick and pockets of carbonized plant matter. Only rarely does any rock contain disseminated uranium, but on the Troutman ranch in the SE¼NE¼ sec. 2, T. 11 N., R. 32 E., in Quay County (locality 24), a roll-like body of disseminated uranium about 1 foot thick forms part of a uranium-bearing layer about 250 feet long. A sample of the roll contained 0.06 percent U_3O_8.

The greatest concentration of deposits in the middle sandstone member is in the Sabinosa district, San Miguel County (localities 29-34). The largest production from the middle member has been from the Bish No. 2 mine in this district. It yielded 30 tons that averaged about 0.10 percent U_3O_8 and 0.40 percent V_2O_5. The main host rock at the Bish mine is limestone-pebble conglomerate containing carbonized plant remains. The only other deposit to yield ore from this member is the Good Luck No. 3 mine in Quay County, which yielded 8.43 tons that averaged 0.22 percent U_3O_8. Trial shipments totaling 80 tons were made from the Good Luck No. 1, Little Rattler, and Windy No. 9 mines.

The upper shale member of the Chinle consists of thin, evenly to irregularly bedded siltstone that weathers dark red and interbeds of claystone, clayey limestone, and sandstone. Greenish-gray beds are virtually absent. Uranium is present only in a thick dominantly dark- to orangish-red shale bed that appears to directly overlie the middle sandstone member at the abandoned Red Peak Mining Company prospect on the Wallace ranch in Quay County (locality 18). Sparse to locally abundant chert nodules containing malachite, azurite, and torbernite (?) are in a zone that crops out for about 1,500 feet around a circular flat playa-like basinal surface. The greatest concentration of nodules is in an area about 200 by 300 feet. The shale containing the nodules is purplish red, and a narrow bluish-gray halo surrounds each nodule. A handpicked sample of nodules contains 0.12 percent U_3O_8, more than 10 percent Cu, o.70 percent V, 0.003 percent Ag, 1.5 percent As, and 0.003 percent Se.

URANIUM IN THE REDONDA FORMATION

The Redonda Formation consists of horizontal uniformly thick interbeds of brownish-red and orangish-red clayey siltstone, fine-grained sandstone, and clayey limestone (Dobrovolny and Summerson *in* Dobrovolny and others, 1946; Griggs and Read, 1959). Several radioactive anomalies have been reported in the lower part of the Redonda in several land sections at Mesa Redonda, Quay County (Grand Junction office, AEC, 1970, p. 96-97). In sec. 3, T. 8 N., R. 31 E. (locality 17), a bed of uniformly radioactive pale-yellowish-green calcareous noncarbonaceous laminated claystone about 8 inches thick rests on maroon claystone and directly underlies thin even-bedded ripple-marked calcareous siltstone and very fine grained sandstone about 80 feet above the base of the Redonda. A channel sample from this bed contained 0.001 percent U_3O_8 and 0.007 percent eU_3O_8. J. W. Allison (Grand Junction Office, AEC, 1970, p. 96-97) reported in 1955 that a sample of "carnotite-type ore" with carbonaceous material from nearby contained 0.033 percent eU_3O_8.

URANIUM IN THE MORRISON FORMATION

Most of the uranium occurrences in the Morrison Formation (Upper Jurassic) are in a small area west of Tucumcari in Quay County. Dobrovolny and Summerson (*in* Dobrovolny and others, 1946) subdivided the Morrison of northern Quay County into three informal members: discontinuous basal green and red shale, containing chalcedony fragments, and thin gray sandstone; middle slope-forming red, green, and purple shale and red or gray sandstone; and upper cliff-forming gray and buff crossbedded locally conglomeratic sandstone and interbedded gray sandy shale. The southern edge of the Morrison depositional basin appears to cross southern Quay County; the Morrison and other Jurassic formations thin markedly toward this area, and the middle member of the Morrison overlaps the basal member. Thus, most of the deposits are probably within 40 miles of the edge of the basin of deposition. Most of the uranium deposits are either in the basal member or near the base of the middle member. The deposits are all associated either with silicified wood or bone or, less commonly, with carbonaceous wood. Most of these silicified materials contain a few tenths percent U_3O_8. Radioactive shale and sandstone associated with wood and bone generally contain a few thousandths percent U_3O_8. At the Breen prospect (locality 26), an epigenetic roll-shaped deposit about 1 foot high consists of bands of limonite and gray organic (?) material disseminated in sandstone, a sample of which contains 0.004 percent $U_3)_8$. A shipment "back east" of about 30 tons of silicified uraniferous logs from the Bel Aro mine (locality 28), is reported by the owner, but not recorded by the Atomic Energy Commission. About 0.8 ton of silicified wood that contained 0.15 percent U_3O_8 and 0.31 percent V_2O_5 was produced from the Polito No. 2 claim (locality 11) in Harding County in 1955, according to the Atomic Energy Commission; this probably came from the Morrison Formation.

URANIUM IN PLEISTOCENE ROCKS

Both Tertiary and Pleistocene sedimentary rocks cover a large portion of eastern New Mexico. Uranium has not been reported from any Tertiary rocks and only two occurrences are in Pleistocene rocks.

Anomalous radioactivity has been detected in dark-red gypsiferous sandy clay of the Gatuna Formation of Pleistocene (?) age exposed in several oil-field drilling-mud pits. The Gatuna Formation is a widespread varied assemblage of terrestrial rocks laid down in the Pecos River valley (W. T. B. Lang *in* Robinson and Lang, 1938, p. 84-85). A sample of radioactive clay collected by the writer on the Moreland and Hooper claims contained 0.002 percent eU_3O_8. Waltman (1954) reported analyses of 0.006 percent U_3O_8 from clay "containing visible specks of carnotite" from a pit near the Moreland and Hooper claims.

All of the widely scattered Pearlette-like volcanic ash beds of Pleistocene age sampled in the southern High Plains of eastern New Mexico and west Texas are noticeably radioactive and contain 0.002-0.004 percent eU_3O_8 (U.S. Geol. Survey, 1971, p. A7). The single deposit in eastern New Mexico occurs at the Acme silica pits in sec. 14, T. 14 N., R. 32 E., northwest of Logan (locality 10). A sample of the uniformly radioactive ash bed contains 0.0035 percent eU_3O_8; delayed-neutron determination of its uranium and thorium content showed 7 and 27 ppm, respectively, assuming a normal 3.7 Th/U ratio (H. T. Millard, Jr., and P. J. Aruscavage, analysts, U.S. Geol. Survey, written commun., 1971). The ash bed and associated sand and gravel beds lie in a depression that is about 60 feet deep at its deepest point, as much as 800 feet wide, and about 1,700 feet long. The ash bed ranges from 0 to 8 feet thick. It is truncated by 15-25 feet or buff very fine grained sand and silt, which in turn is overlain by 0-5 feet of coarse gravel made up igneous and metamorphic rocks. The ash bed is underlain by 0-15 feet of orange very fine grained sand and silt, and a basal gravel of quartz, chert, and sedimentary rocks 0-8 feet thick. Carbonized logs and coaly seams in the Triassic rocks beneath and surrounding the depression are radioactive.

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