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DEPARTMENT OF THE INTERIOR
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A RECONNAISSANCE FOR URANIUM IN NEW MEXICO 1953

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UNITED STATES DEPARTMENT OF THE INTERIOR
Douglas McKay, Secretary

GEOLOGICAL SURVEY
W. E. Wrather, Director

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By Roy L. Griggs

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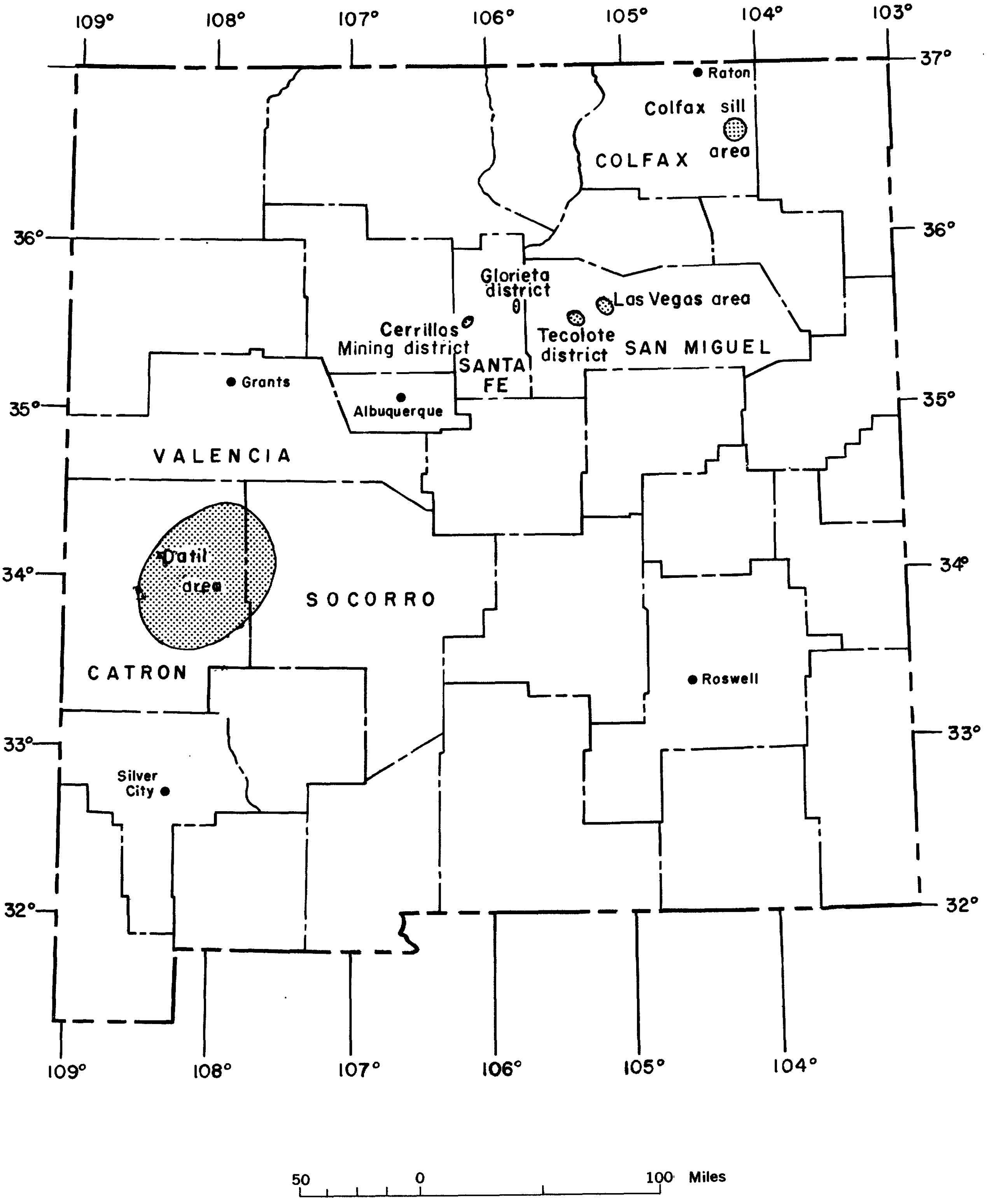

Figure 1.—Index map of New Mexico showing areas examined.

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1953

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ABSTRACT

In the fall of 1953 a reconnaissance for uranium was made in the Datil area of west-central New Mexico, and in the Cerrillos mining district, the Glorieta and Tecolote districts, and the Las Vegas and Colfax sill areas of north-central to northeastern New Mexico. Traces of radioactive materials were detected at many places, and deposits of uranium minerals, which may be of possible economic significance, were found near the village of Datil. Small amounts of uranium are widespread in sandstone beds in the Mesaverde formation. The sample of highest grade contained 0.056 percent uranium.

INTRODUCTION

During the fall of 1953 the writer made a reconnaissance for uranium in several areas of New Mexico. The work was undertaken on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission and was a continuation of investigations begun in New Mexico in 1951 by Bachman and Read (written communication, 1952). Some of the areas were selected for examination in 1953 as a result of the work of the 1951 and 1952 investigations.

The several areas examined are in west-central and north-central to northeastern New Mexico (fig. 1). Most of these areas showed evidence for the occurrence of uranium, and the area in west-central New Mexico, may contain deposits of economic significance near the village of Datil.

Each area was traversed by automobile and on foot; portable scintillation and Geiger counters were used as detection equipment. Possible source and receptor rocks were examined and sampled, and the samples were analyzed by the Denver laboratory of the U. S. Geological Survey.

DATIL AREA

Geography

The Datil area is in eastern Catron and western Socorro Counties, in the west-central part of the state; the village of Datil is a short distance northeast of the geographic center of the area (fig. 2). The area is a highland surrounding a large depression, the Plains of San Augustin, that trends northeastward, and lies just inside the southwestern margin of the Colorado Plateaus. The highland is in several stages of dissection. In some places it is mountainous, and in others it is a gently sloping plateau. The Plains of San Augustin, a closed depression, is covered by Quaternary deposits.

Most parts of the area are accessible from U. S. Highway 60, State Route 12, and several secondary roads.

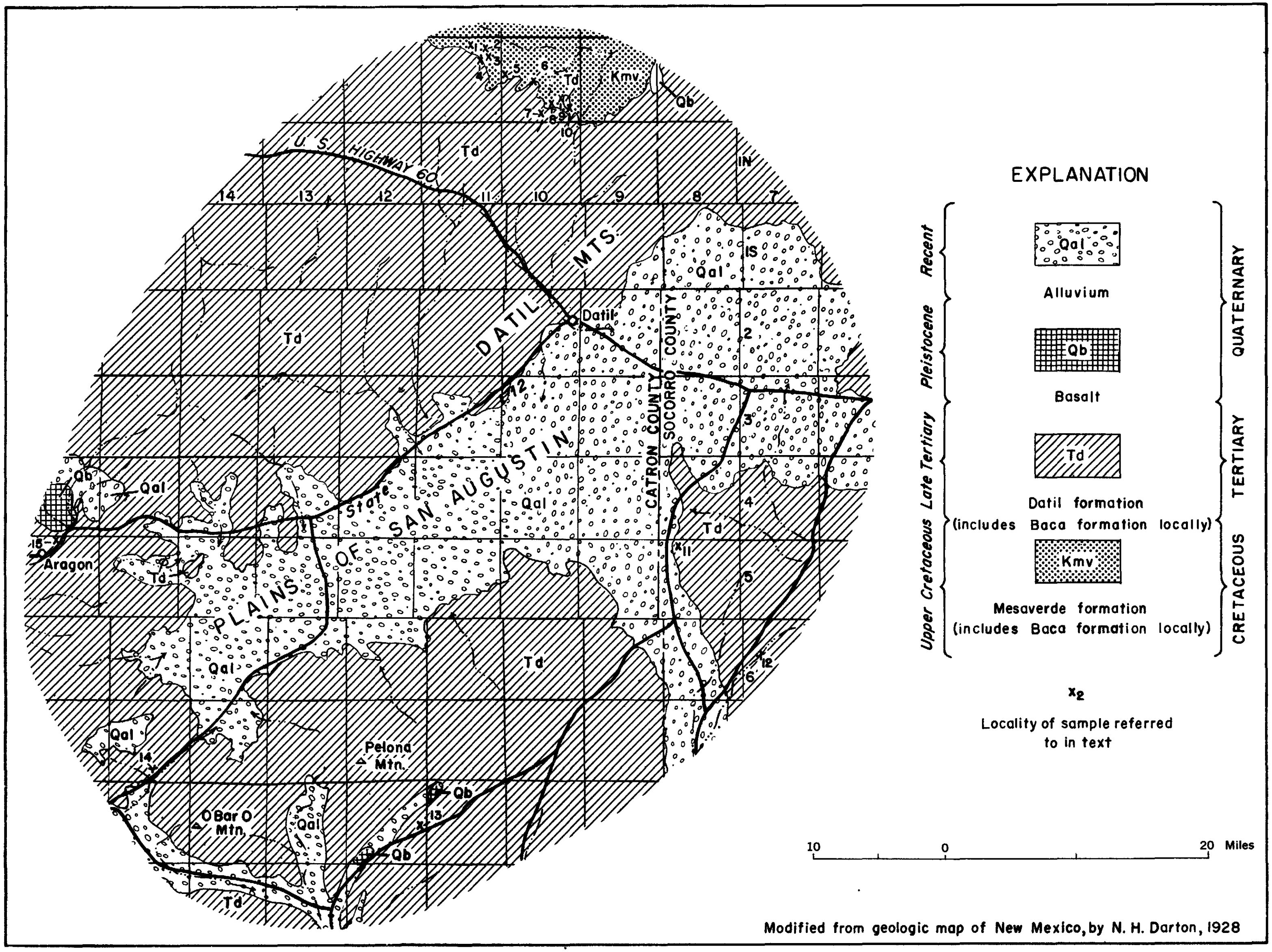

Figure 2. —Geologic map of Datil area, Catron and Socorro Counties, New Mexico.

Geology

Relatively little is yet known of the regional geology. The rocks of the area are in large part of volcanic origin and are of late Tertiary age, but Upper Cretaceous and lower Tertiary sedimentary rocks are present at the northern tip of the area, and Quaternary alluvium is widespread within the Plains of San Augustin. Locally, some Quaternary basalt also is present.

Stratigraphy

The Upper Cretaceous and lower Tertiary rocks at the northern tip of the area belong to the Mesaverde and Baca formations (fig. 2). The Mesaverde formation is by far the more extensive of these two units, and where examined, it consists of two general types of rocks. A lower part is at least 250 feet thick, is undifferentiated into members, and is composed mainly of dark carbonaceous shale and grayish sandstone. The shale commonly weathers greenish gray. The upper part of the formation, is a distinct member about 300 feet thick and composed mainly of light-gray to gray sandstone, which weathers greenish buff and forms prominent cuestas. Carbonaceous shale, interbedded with the sandstone, generally occurs as relatively thin lentils.

The Baca formation of early Tertiary age is exposed between outcrop bands of the Mesaverde formation and the Datil formation. It lies disconformably on the upper part of the Mesaverde and is composed of an alternating sequence of beds of gray sandstone and maroon shale. The unit has a thickness of about 1,000 feet.

An angular unconformity separates the Datil formation, of late Tertiary age, from the underlying Mesaverde and Baca formations. The Datil is composed dominantly of rhyolitic materials. The lower part is made up mainly of water-washed and water-laid silt, sand, and gravel, which is more or less admixed with tuffaceous debris. The upper part is made up mainly of welded tuff but contains some associated rhyolite extrusives.

Quaternary deposits of unconsolidated material cover much of the Plains of San Augustin, and Quaternary basalt flows underlie local areas.

Structure

The structure of the area is generally simple. The Mesaverde and Baca formations at the north end of the area generally dip from 2 to 10 degrees to the south and southwest. Above the angular unconformity that truncates the underlying formations the volcanic rocks of the Datil formation are nearly horizontal. North of the Plains of San Augustin, however, these rocks dip about 1 to 2 degrees both to the north and to the south, and south of the Plains of San Augustin they dip about 2 degrees to the south. Normal faults are present along the margins of the Plains of San Augustin, although the faults are largely concealed by alluvium. Beds of welded tuff that are downfaulted to low elevations in the interior of the plains, and rhyolite domes in the interior and at the margins of the plains suggest that this prominent closed depression is a collapsed structure related to the eruption of the associated welded tuff.

Uranium deposits

Uranium minerals in the Datil area were noted first by Mr. Jeff Tietjen, a local rancher, who found radioactivity in several localities in the winter of 1951-52.

Uranium occurs in traces in some of the rocks of the Datil formation, but the best deposits are in the upper part of the Mesaverde (fig. 3). Uranium was detected in this cuesta-forming sandstone unit at several localities in a narrow belt north of and parallel to the contact of the Mesaverde and the overlying Datil formation. These localities are in T. 2 N., Rs. 10 and 11 W. (fig. 2) and are distributed along the outcrop of the sandstone member for a distance of about 10 miles. Uranium may occur at other localities in this same belt of outcrop, which extends to the southeast and to the northwest of the known uranium-bearing areas. The total length of the belt in the sandstone member may be about 15 miles. Uranium may also occur in the sandstone downdip to the south beneath the Baca and Datil formations and updip to the north. The Baca formation is another possibility. This lower Tertiary unit, overlain with angular unconformity by the Datil formation, may have transmitted uraniferous solutions, and uranium minerals may have been precipitated in places where conditions were favorable.

In the Mesaverde formation these uranium minerals are generally localized at the contact of beds of sandstone and shale, and the highest grade material lies in the basal parts of those sandstone beds that lie directly above shale beds. Less intense radioactivity indicates that uranium minerals are present in the uppermost few inches of the underlying shale. The zone of most intense mineralization generally ranges in thickness from a feather edge to about 3 inches. The best deposit found thus far is not of commercial grade. The two best samples (nos. 2 and 3a) contain 0.056 and 0.042 percent uranium respectively. However, little is known of the lateral extent of mineralization in any given deposit, owing to the reconnaissance nature of the survey, and because the mineralized zones are largely covered by talus.

The uranium minerals appear to be of the carnotite type and are associated with organic material and limonite. At most localities the organic material consists of carbonized leaves and twigs, or disseminated plant remains. Some beds of sandstone appear to be oil stained. The limonite occurs as thin films or layers deposited along the bedding plane between mineralized sandstone and the underlying shale. At several localities the limonite contains radioactive material, and at two localities it is associated with a yellow uranium mineral.

Field-counter measurements indicate that the oldest parts of the Datil formation, the water-washed and water-laid silts, sands, and gravels and the older welded tuffs, are essentially nonradioactive. The youngest rocks of the Datil formation, however, such as the younger welded tuffs and the rhyolite domes, are radioactive and contain traces of uranium.

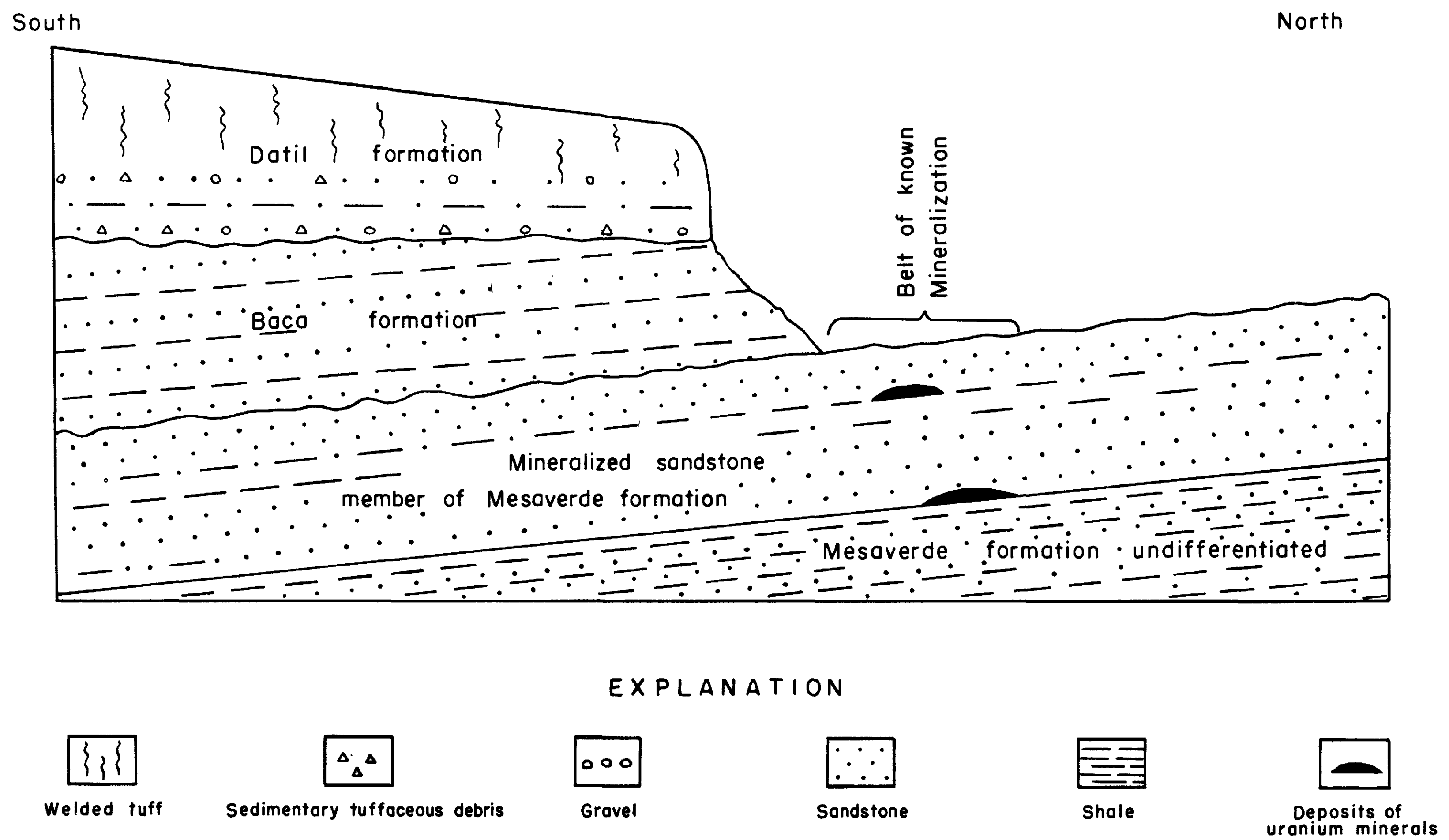

Figure 3.—Diagrammatic cross section of the northern part of the Datil area showing stratigraphy, structure, and deposits of uranium minerals.

A sample from locality 13 (fig. 2, and p. 7) is considered to be representative of the younger welded tuffs. This sample (no. 13) contains 0.003 percent equivalent uranium and 0.0006 percent uranium. Samples from the rhyolite domes at localities 11, 14, and 15 all contain 0.003 percent equivalent uranium, and 0.0005, 0.0006, and 0.0011 percent uranium, respectively.

Origin

The uranium minerals in the sandstone member of the Mesaverde formation probably were deposited by ground water after the consolidation of the sandstone and associated shale. Deposition by ground water is indicated by (1) the occurrence of mineralized zones in sandstone directly above beds of impervious shale, and by (2) the apparent lack of a relation of the mineralization to a fracture system. The characteristic occurrence of a thin crust of limonite along bedding planes between mineralized sandstone and underlying shale beds indicates that the rocks were consolidated before formation of the limonite, although the limonite may be pseudomorphous after a parent iron-bearing mineral. Field-counter measurements show that the limonite invariably contains some uranium, and at two localities the limonite is closely associated with a yellow uranium mineral. At one of these localities the uranium mineral impregnates the basal part of a sandstone bed directly above a limonitic crust. At the other locality the uranium mineral occurs as irregular stained patches within the limonite. The uranium mineral may have been deposited at the same time as the limonite or later.

Descending meteoric waters may have leached radioactive material from tuffaceous rocks of the Datil formation and carried and deposited it at its present locations in the Mesaverde formation. The belt of known mineralization is closely associated with the tuffaceous rocks of the Datil formation that rest with angular unconformity on the mineralized sandstone member of the Mesaverde.

CERRILLOS MINING DISTRICT

The Cerrillos mining district is in the Cerrillos Hills in west-central Santa Fe County, about 15 miles southwest of the town of Santa Fe. The district has been relatively unimportant as a metal producer but has been intermittently active for a long time. Silver, lead, zinc, and a little copper have been produced since 1879, and turquoise was mined by the Indians before the arrival of the Spaniards. The value of minerals produced between 1904 and 1928 amounted to about $175,000 (Lasky and Wootton, 1933, p. 95).

The mineralized parts of the district are associated with a group of small intrusives of monzonitic composition that have invaded sedimentary rocks of Late Cretaceous and early Tertiary age. Most of the deposits are localized in steeply dipping shear zones that cut the intrusives (Lindgren, Graton, and Gordon, 1910, p. 167). Silver-bearing galena, sphalerite, and chalcopyrite are the chief ore minerals.

The reconnaissance survey of the district found little radioactive material associated with the lead-zinc minerals. However, a low level of radioactivity in the district, was found invariably to accompany a type of alteration that is best developed in association with the turquoise deposits of the area. Rocks affected by this type of alteration are readily recognizable as white to light-gray, and by the presence of kaolinite(?) and fine-grained silica. These altered rocks are found along shear zones that cut some of the intrusives and in highly fractured ground adjacent to the shear zones. The reconnaissance examination suggests that the areas of altered rock may be found only in a fine-grained gray latite. The areas of greatest alteration were seen at the 2 abandoned turquoise mines in the district. One mine is in the southeastern part of the district in sec. 5, T. 14 N., R. 8 E., and the other is in a low hill to the northeast of the main part of the district in sec. 21, T. 15 N., R. 8 E. A sample (no. 16) of altered material taken at the first mine contains 0.003 percent equivalent uranium and 0.0009 percent uranium. Turquoise (no. 16a), hand separated from the sample, contains 0.002 percent equivalent uranium and 0.0007 percent uranium. Two samples were collected at the other mine in the northeastern part of the district. Both contain small amounts of turquoise. One sample (no. 18) contains 0.009 percent equivalent uranium and 0.0085 percent uranium, and the other (no. 19) contains 0.007 percent equivalent uranium and 0.001 percent uranium. A sample of relatively unaltered intrusive rock from this locality contains 0.003 percent equivalent uranium and 0.0005 percent uranium (no. 20). Rocks at other localities are less altered, for example, at the old Evelyn mine in sec. 19, T. 15 N., R. 8 E., where the alteration is associated with oxidized copper minerals. A sample (no. 21) from this mine contains 0.005 percent equivalent uranium and 0.0007 percent uranium.

Two other samples were collected in the district. No. 17 is a sample of a relatively fresh, medium-grained monzonite and was collected from the dump of the Cash Entry mine in sec. 5, T. 14 N., R. 8 E. It contains 0.002 percent equivalent uranium and 0.001 percent uranium. Sample no. 22 was taken in sec. 8, T. 14 N., R. 8 E. at locality 22 where Mancos shale is in contact with one of the intrusive bodies. The slightly altered shale contains 0.002 percent equivalent uranium and 0.0004 percent uranium.

GLORIETA DISTRICT

The Glorieta district lies near the village of Glorieta in east-central Santa Fe County, about 15 miles southeast of the town of Santa Fe. The northern part of the district is a part of the rugged terrain at the southern end of the Rocky Mountains, and the southern part is a part of the top of Glorieta Mesa, a prominent plateau immediately south of the mountains. The surface rocks are sedimentary rocks of Pennsylvanian and Permian age that are folded into a broad, southerly plunging syncline in which dip of the strata ranges from about 10 degrees in the northern part to about 5 degrees in the southern part of the area (Read and others, 1944).

Iron and copper ores were mined in the district about 1900. About 3,500 tons of iron ore was shipped from the Kennedy mine in the southern part of the area (Kelley, 1949, p. 197), and perhaps a few hundred tons of copper ore was shipped from prospects in the northern part of the area. At the Kennedy mine, in sec. 23(?), T. 15 N., R. 11 E. on Glorieta Mesa, the ore minerals are limonite and hematite that occur in a replacement deposit in sandstone in the San Andres formation. The ore body is tabular and dips about 5 degrees to the west, and where mined it averaged about 3 feet in thickness. The abandoned workings consist of a small opencut and several hundred feet of tunnels and rooms.

The copper ore was mined from redbed copper deposits in the Sangre de Cristo formation that crops out mainly along La Cueva Creek in the northern part of the district. Chalcocite, malachite, and azurite are disseminated in arkose beds in the lower part of the Sangre de Cristo formation, which dips about 10 degrees to the west.

Samples were collected at two localities in the Glorieta district. A grab sample (no. 24) of hematite ore from the Kennedy mine contains 0.001 percent equivalent uranium and 0.0005 percent uranium. A grab sample (no. 23) of copper ore from a 3-foot bed of arkose in sec. 14, T. 16 N., R. 11 E. contains 0.002 percent equivalent uranium and 0.0004 percent uranium. Copper prospects in Glorieta Canyon are not radioactive and were not sampled.

TECOLOTE DISTRICT

The Tecolote district lies in western San Miguel County, about 10 miles southwest of Las Vegas. The exposed rocks are, in ascending order, the Magdalena group of Pennsylvanian age, the Sangre de Cristo formation of Pennsylvanian and Permian(?) age, and the Yeso and San Andres formations of Permian age. Along the western margin of the area these rocks form a steep, easterly dipping monocline, but over the greater part of the area they are nearly horizontal (Read and others, 1945; Northrop and others, 1946).

The district has several abandoned prospects and two abandoned mines that were worked for copper about 1900 and again during the First World War. The deposits occur in arkose beds in the Sangre de Cristo formation. The ore minerals are chalcocite, bornite, malachite, and azurite (Lindgren, Graton, and Gordon, 1910, p. 116-123).

In 1953 several of the abandoned prospects were examined for radioactivity. All prospects examined are within the boundaries of the Tecolote Grant, most of them on a hill about 1 mile north of the village of Santana. Other prospects visited are about half a mile east of Santana, about 1 mile west of Tecolote, and about 2 miles northwest of Tecolote. No samples were taken from the prospects, as very little radioactivity was noted.

One of the abandoned mines, the Blake mine, was examined. It is in sec. 8, T. 14 N., R. 15 E., along the monocline in the western part of the district. At this place an arkose bed about 10 feet thick has been mined for a distance of about 250 feet along the strike and for a distance of about 25 feet down the dip. A sample (no. 26) of copper-bearing rock collected from the dump contains 0.003 percent equivalent uranium and 0.0004 percent uranium.

Two other samples were collected in the Tecolote district. One was from an area of greenish rock in an arkose bed at a place a quarter of a mile west of Tecolote. Although no copper minerals were observed at this place, a field-counter measurement was higher than those at any copper prospect in the district. This sample (no. 25) contains 0.002 percent equivalent uranium and 0.0003 percent uranium. Another sample was taken from a 2-foot bed of coal in the Madera limestone in sec. 8, T. 14 N., R. 15 E. A channel sample (no. 24) of this coal contains 0.001 percent equivalent uranium and 0.0004 percent uranium.

LAS VEGAS AREA

Triassic, Jurassic, and Cretaceous sedimentary rocks are well exposed in the vicinity of Las Vegas, in western San Miguel County (Northrop, and others, 1946). These sediments were tested for radioactivity at several localities. At Kearny and Romeroville Gaps, 2 and 5 miles, respectively, southwest of Las Vegas, and at a point 10 miles southeast of Las Vegas, on State Route 20, traces of radioactivity are present in the Morrison and Purgatoire formations. In the Morrison formation several beds as much as 3 feet thick show traces of radioactivity. A 3-foot bed of shale at Romeroville Gap was selected as representative of this radioactive material in the Morrison and was sampled. The sample (no. 28) contains 0.005 percent equivalent uranium and 0.002 percent uranium.

At the three localities the top of the Purgatoire formation contains a bed of black shale about 20 feet thick. A representative sample (no. 29) taken from this shale at Romeroville Gap contains 0.002 percent equivalent uranium and 0.0009 percent uranium. Bentonitic rocks in the Graneros shale show traces of radioactivity at a locality a quarter of a mile east of Las Vegas on State Route 65. Ten beds of bentonite ranging from one-eighth inch to nearly 1 foot in thickness occur in a stratigraphic interval of about 50 feet. A representative sample (no. 30) collected from one of the beds contains 0.003 percent equivalent uranium and 0.0012 percent uranium.

COLFAX SILL AREA

In eastern Colfax County an area of about 100 square miles contains many sills of monzonitic and syenitic composition. Most of these sills are emplaced in the Graneros and Carlile shales of Late Cretaceous age, although a few sills occur in Jurassic sedimentary rocks. A rapid survey showed that many, perhaps most, of these intrusive rocks contain traces of radioactive materials, and one type of porphyry, a distinctive grayish-green rock having large feldspar phenocrysts, appears to be slightly more radioactive than other types. A sample (no. 31) of this rock taken in sec. 6, T. 27 N., R. 26 E. contains 0.008 percent equivalent uranium and 0.0041 percent uranium. A dike, about 10 feet wide, that leads to the overlying sill at a nearby locality cuts the Carlile shale, and the shale is conspicuously altered for a distance of 5 to 10 feet on both sides of the dike. A sample (no. 32) of the altered shale contains 0.002 percent equivalent uranium and 0.0004 percent uranium.

RADIOACTIVITY AND CHEMICAL ANALYSES OF SAMPLES COLLECTED

Sample no.	Laboratory serial no.	Equivalent uranium (percent)	Uranium (percent)	Description and locality
				Samples from the Datil area
1	201449	0.074	0.004	A channel sample of a lens of sandstone in the cuesta-forming sandstone member of the Mesaverde formation at a point where the lens is 1 foot thick. The sandstone contains carbonized leaves and twigs. Sec. 10 or 11, T. 2 N., R. 11 W.
2	201454	.062	.056	A selected sample of the lower 3 inches of a sandstone bed in the cuesta-forming sandstone member of the Mesaverde formation. The zone contains carbonized leaves. Sec. 11 or 14, T. 2 N., R. 11 W.
3a	201447	.056	.042	A selected sample of the lower inch of a sandstone bed in the cuesta-forming sandstone member of the Mesaverde formation. The sample contains a yellow uranium mineral. Sec. 14, T. 2 N., R. 11 W.
3b	201448	.003	.0017	A grab sample of the upper 2 feet of black shale immediately below sandstone bed from which sample 3a was taken.
4	201450	----------	[1].022	A water sample from the well at the McPhaul ranch (sec. 14, T. 2 N., R. 11 W.). The well obtains water from the cuesta-forming sandstone member of the Mesaverde formation.
5a	201440	.016(?)	.022	A grab sample of the lower 8 inches of a sandstone bed in the cuesta-forming sandstone member of the Mesaverde formation. The sandstone contains shale pellets. Sec. 18 or 19, T. 2 N., R. 10 W.
5b	201441	.051	.019	A selected sample of the lower 2 inches of a sandstone bed in the cuesta-forming sandstone member of the Mesaverde formation. Sec. 18 or 19, T. 2 N., R. 10 W.
5c	201442	.025	.004	Limonite deposited along bedding plane immediately below the bed from which sample 5b was taken.
5d	201443	.005	.002	A grab sample of the uppermost foot of black shale immediately below the bed of sample 5c. This shale also is immediately below the cuesta-forming sandstone member of the Mesaverde.
6	201444	.004	.002	A grab sample of sandstone from the cuesta-forming sandstone member of the Mesaverde formation. The sample contains pieces of carbonized wood. Sec. 21, T. 2 N., R. 10 W.
7	201451	----------	[1].036	A water sample from the well at the Webster ranch (sec. 34, T. 2 N., R. 10 W.). The well obtains water from the cuesta-forming sandstone member of the Mesaverde formation.
8	201439	.013	.011	A grab sample of the lowest 6 inches of a sandstone bed in the cuesta-forming sandstone member of the Mesaverde formation. Sec. 27, T. 2 N., R. 10 W.
9	201446	.095	.017	A selected sample of the lowest inch of a sandstone bed in the cuesta-forming sandstone member of the Mesaverde formation. The sample includes a thin crust of limonite, which occurs along the bedding plane beneath the sandstone. A yellow uranium mineral occurs in this limonite. Sec. 26(?), T. 2 N., R. 10 W.
10	201445	.023	.026	A grab sample of the lowest 4 inches of a sandstone bed in the cuesta-forming sandstone member of the Mesaverde formation. Sec. 26, T. 2 N., R. 10 W.
11	201437	.003	.0005	A grab sample of a rhyolite dome. Sec. 5(?), T. 5 S., R. 8 W.
12	201452	----------	[1].001	A sample of water from a spring that emerges from rhyolite tuff. Sec. 20(?), T. 6 S., R. 7 W.
13	201436	.003	.0006	A grab sample of welded tuff. Sec. 24(?), T. 8 S., R. 12 W.
14	201438	.003	.0006	A grab sample of a rhyolite dome. Sec. 34(?), T. 7 S., R. 15 W.
15	201434	.003	.0011	A grab sample of a rhyolite dome. Sec. 3, T. 5 S., R. 16 W.
16	201419	.003	.0009	A grab sample of kaolinized(?) and silicified latite from a turquoise mine in sec. 5, T. 14 N., R. 8 E.
16a	201420	.002	.0007	A selected sample of turquoise separated from sample 16.
17	201421	.002	.0010	A grab sample of a medium-grained monzonite from the dump of the Cash Entry mine. Sec. 5, T. 14 N., R. 8 E.

See footnote at end of table.

RADIOACTIVITY AND CHEMICAL ANALYSES OF SAMPLES COLLECTED—CONTINUED

Sample no.	Laboratory serial no.	Equivalent uranium (percent)	Uranium (percent)	Description and locality
				Samples from Datil area—Continued
18	201424	0.009	0.0085	A grab sample of kaolinized(?) and silicified latite from a turquoise mine in sec. 21, T. 15 N., R. 8 E. Clay is predominant in this sample.
19	201425	.007	.0010	A grab sample of kaolinized(?) and silicified latite from the same locality as sample 18.
20	201423	.003	.0005	A grab sample of relatively unaltered latite from the same locality as sample 18.
21	201426	.005	.0007	A grab sample of kaolinized(?) and silicified latite from the Evelyn copper mine. Sec. 19, T. 15 N., R. 8 E.
22	201422	.002	.0004	A grab sample of slightly altered shale from the Mancos formation adjacent to the contact with a monzonitic intrusive. Sec. 8, T. 14 N., R. 8 E.
				Samples from the Glorieta district
23	201427	0.002	0.0004	A grab sample of copper ore from a 3-foot bed of arkose in the Sangre de Cristo formation. Sec. 14(?), T. 16 N., R. 11 E.
24	201428	.001	.0005	A grab sample of iron ore from the San Andres formation at the old Kennedy mine. Sec. 23(?), T. 15 N., R. 11 E.
				Samples from the Tecolote district
25	201431	0.002	0.0003	A grab sample from an area of green rock in an arkose bed in the Sangre de Cristo formation. The locality is one-quarter mile west of the village of Tecolote.
26	201430	.003	.0004	A grab sample of copper ore collected from the dump of the old Blake mine in sec. 8, T. 14 N., R. 15 E.
27	201429	.001	.0004	A channel sample of a bed of coal 2 feet thick in the Madera limestone. Sec. 8, T. 14 N., R. 15 E.
				Samples from the Las Vegas area
28	201432	0.005	0.0020	A channel sample of a bed of shale 3 feet thick in the Morrison formation. The locality is Romeroville Gap, 5 miles south of Las Vegas, N. Mex.
29	201433	.002	.0009	A channel sample of a bed of bony shale, one foot thick, present in a carbonaceous shale unit in the Purgatoire formation. The locality is Romeroville Gap, 5 miles south of Las Vegas, N. Mex.
30	201434	.003	.0012	A channel sample of a 10-inch bentonite bed in the Graneros shale. The locality is one-quarter mile east of Las Vegas, N. Mex.
				Samples from the Colfax sill area
31	201455	0.008	0.0041	A grab sample of a grayish-green sill emplaced in the Carlile shale in sec. 6, T. 27 N., R. 26 E.
32	201456	.002	.0004	A grab sample of altered Carlile shale adjacent to a dike. Sec. 6, T. 27 N., R. 26 E.

[1] In parts per million.

LITERATURE CITED

Kelley, V. C., 1949, Geology and economics of New Mexico iron-ore deposits: N. Mex. Univ. Pubs. in Geology, no. 2, p. 195-197.

Lasky, S. G., and Wootton, T. P., 1933, The metal resources of New Mexico and their economic features: N. Mex. Bur. Mines Bull. 7.

Lindgren, W., Graton, L. C., and Gordon, C. H., 1910, The ore deposits of New Mexico: U. S. Geol. Survey Prof. Paper 68.

Northrop, S. A., Sullwold, H. H., MacAlpin, A. J., and Rogers, C. P., 1946, Geologic maps of a part of the Las Vegas basin and of the foothills of the Sangre De Cristo Mountains, San Miguel and Mora Counties, New Mexico: U. S. Geol. Survey Oil and Gas Inv. Prelim. Map 54.

Read, C. B., Wilpolt, R. H., Andrews, D. A., Summerson, C. H., and Wood, G. H., 1944, Geologic map and stratigraphic sections of Permian and Pennsylvanian rocks of parts of San Miguel, Santa Fe, Sandoval, Bernalillo, Torrance, and Valencia Counties, north-central New Mexico: U. S. Geol. Survey Oil and Gas Inv. Prelim. Map 21.

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