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1. Bachman, G.O., et al. "Reconnaissance for Uranium-Bearing Carbonaceous Rocks in New Mexico." *Trace Elements Investigations Report 198*, 1952, United States Department of the Interior Geological Survey.
    a. Page 5-11

2. United States Department of the Interior Geological Survey. "Trace Elements Reconnaissance Investigations in New Mexico and Adjoining States in 1951." *Trace Elements Memorandum Report 433*, 1951.
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    a. Pages 5-6, 10

4. Stead, Frank W. "Airborne Radioactivity Survey in the Vicinity of Grants, McKinley and Valencia Counties, New Mexico." *Trace Elements Memorandum Report 161 United States Department of the Interior Geological Survey*, July 1951.
    - Pages 4, 13

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Reconnaissance for Uranium-Bearing Carbonaceous Rocks in New Mexico, 1952

By G. O. Bachman, E. H. Baltz, and R. B. O'Sullivan

Trace Elements Investigations Report 198

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UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

RECONNAISSANCE FOR URANIUM-BEARING CARBONACEOUS ROCKS IN NEW MEXICO, 1952*

By

G. O. Bachman, E. H. Baltz, and R. B. O'Sullivan

March 1953

Trace Elements Investigations Report 198

This preliminary report is distributed without editorial and technical review for conformity with official standards and nomenclature. It is not for public inspection or quotation.

*This report concerns work done on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

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RECONNAISSANCE FOR URANIUM-BEARING CARBONACEOUS ROCKS IN NEW MEXICO, 1952

By

G. O. Bachman, E. H. Baltz, and R. B. O'Sullivan

ABSTRACT

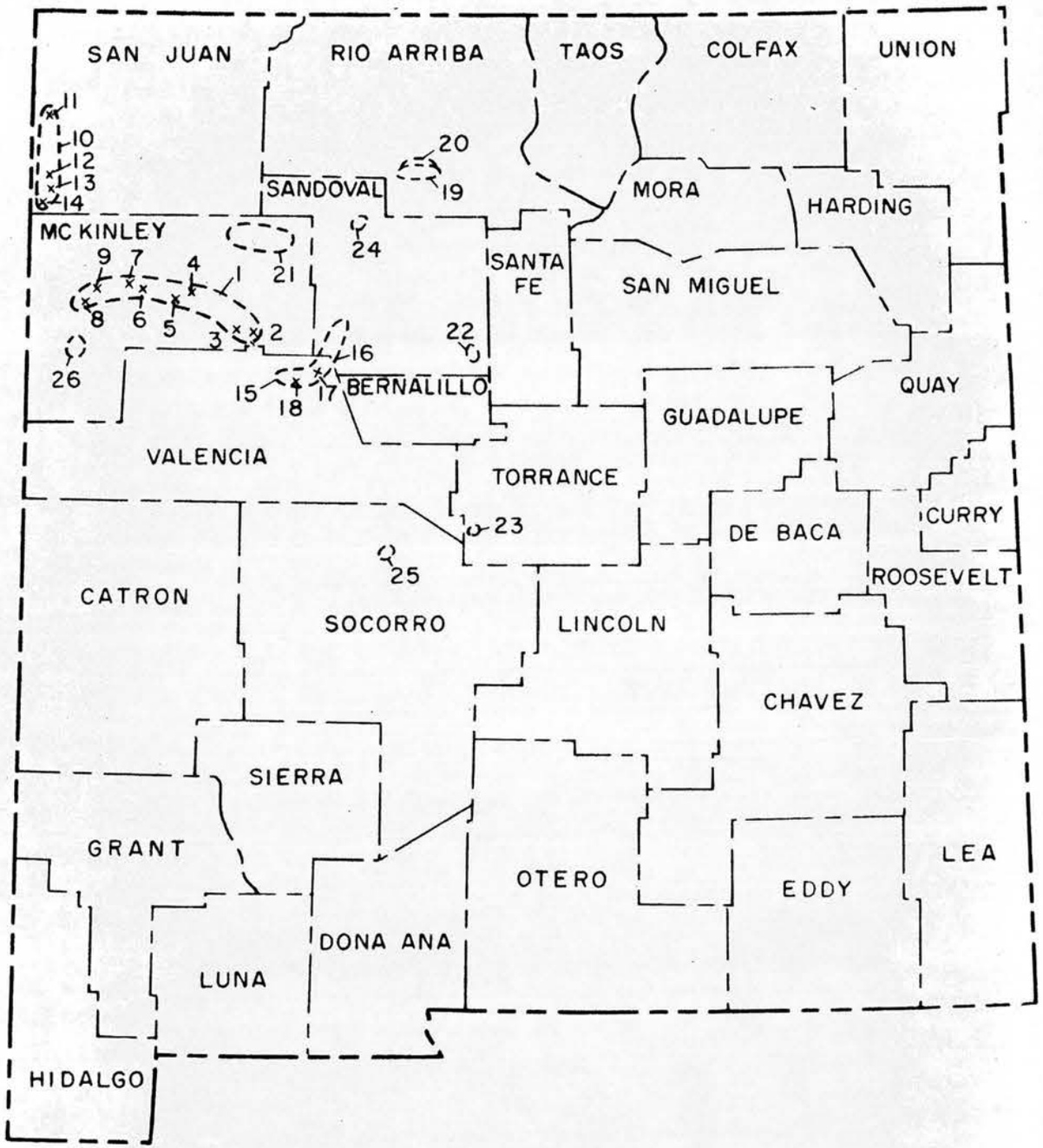
Reconnaissance for uranium in coal and black shale in New Mexico during 1952 was largely an extension of work initiated during the 1951 field season. No uranium deposits of economic interest were found, although minor amounts of uranium were noted at several localities.

INTRODUCTION

During the 1952 field season the writers made a geologic reconnaissance search for uranium in coal and black shale (fig. 1). The work was chiefly a continuation of reconnaissance studies initiated in 1951 (Bachman and Read, 1952). Several areas outlined for study in 1951, were examined more thoroughly during 1952, and several new occurrences of uranium were found. Analyses were made in the Denver and Washington Trace Elements Laboratories of the Geological Survey. This work was done on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

SOUTH MARGIN OF SAN JUAN BASIN, McKINLEY COUNTY

Upper Cretaceous rocks form the southern rim of the San Juan Basin, McKinley County. These rocks were examined between Grants and Gallup, a distance of about 60 miles, in July 1952. Upper Cretaceous rocks listed in ascending order are the Dakota sandstone, the Mancos shale, and the Mesaverde formation. The Mesaverde formation and the upper part of the Mancos shale



Index Map of New Mexico

0 10 30 50 MILES
SCALE

EXPLANATION

1. South margin of San Juan Basin
   2. San Mateo dome
   3. Canyon Mulatto
   4. Satan Pass
   5. Hosta Butte
   6. Mariana Pass
   7. Dalton Pass
   8. Pyramid Rock
   9. "Kit Carson's Cave"

10. Chuska Mountain area
    11. Beautiful Moutain
    12. Toadlena
    13. Washington Pass
    14. Crystal

15. Mount Taylor and vicinity
    16. Mesa Chivato
    17. Seboyeta Canyon
    18. Guadalupe Canyon

19. Gallina-Coyote area
    20. Mesa Alta

21. Chacra Mesa
22. Hagen Basin
23. Scholle Copper district
24. Cuba Mesa area
25. San Acacia area
26. Gallup-Zuni basin

FIGURE 1

have been subdivided into several members by Sears (1934).

The structure of the southern part of the San Juan Basin is relatively simple. From the southern rim of the basin, which is arbitrarily defined as the southern line of outcrop of the Dakota sandstone, strata dip 3° to 10° northward into the basin. Mount Taylor, a late Tertiary volcano, and the Zuni uplift are prominent geographic and structural features at the south edge of the basin.

Carbonaceous material occurs in the Dakota sandstone and in the Gallup, Dilco, and Gibson members of the Mesaverde formation (Sears, 1934). Outcrops were given careful examination for several miles at many places. Radioactivity was found in carbonaceous material in the Dakota sandstone and in the lower Gibson member of the Mesaverde formation.

Radioactivity in the lower Gibson member occurs in discontinuous zones of shale, coal, and carbonaceous material near the contact of the lower Gibson member with the overlying Hosta sandstone. The lower Gibson member and the Hosta sandstone member of the Mesaverde formation crop out at San Mateo dome, about 5 miles north of San Mateo. This zone was examined carefully for a distance of about 3 miles along the south edge of the dome without finding abnormal radioactivity.

At the head of Canyon Mulatto, 6 miles northwest of the San Mateo dome, in the NW¼, sec. 24, T. 14 N., R. 9 W., radioactivity was found in the lower Gibson member directly below its contact with the overlying Hosta sandstone. A lens of coaly material about 3 inches thick contains 0.035 percent uranium (BONM-5)1/. A sample from the basal portion of the Hosta sandstone

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1/ Sample numbers are listed by area in the Appendix.

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at this locality contained 0.005 percent equivalent uranium and 0.002 percent uranium (BONM-13).

On the north side of Canyon Mulatto in the N½ sec. 14, T. 14 N., R. 9 W., uranium was found in a discontinuous lens of shale 2½ inches thick at the base of the Hosta sandstone. The shale contains 0.020 percent equivalent uranium and 0.014 percent uranium (BONM-6). A grab sample taken from the Gibson member at the contact with the Hosta sandstone about 85 feet west of this locality contained 0.007 percent uranium (BONM-7).

This zone of radioactivity was examined continuously from locality BONM-6 eastward into the south half of section 12 and the north half of section 13 on both sides of the canyon. On the north rim of Canyon Mulatto in the SE¼, sec. 12, T. 14 N., R. 12 W. a 1-foot bed of carbonaceous shale in the lower Gibson member was sampled directly below the contact of the lower Gibson member with the Hosta sandstone. The sample contained 0.014 percent equivalent uranium and 0.005 percent uranium (BONM-14). The radioactivity was in the trough of a minor syncline. The syncline is approximately 150 feet wide, and its axis trends nearly north.

The Mesaverde formation was examined at many places west of Canyon Mulatto. In secs. 27 and 28, T. 15 N., R. 10 W. the stratigraphic section was examined carefully in the vicinity of the Ambrosia Fault (Hunt, pl. 18, 1936). Particular attention was given to the lower Gibson-Hosta contact in the W½ sec. 27 and in sec. 28. No abnormal radioactivity was noted in this area and no samples were collected.

Lower Gibson and Hosta rocks are exposed for a distance of about 5 miles on the sides of a prominent cuesta that extends from sec. 31, T. 16 N., R. 11 W. westward to Satan Pass. These exposures were examined throughout most

of their length but radioactivity was found only at one locality east of the Thoreau-Crown Point road. In sec. 32, T. 16 N., R. 12 W. a radioactive coal bed 1-foot thick was found near the lower Gibson-Hosta contact. The uranium content of the coal apparently is discontinuous as different points on any one horizon examined did not show equal radioactivity. The coal contained 0.003 percent equivalent uranium, 0.005 percent uranium, and 0.034 percent uranium in the ash (BONM-9). Carbonaceous shale at the same locality contained 0.003 percent equivalent uranium (BONM-10). A channel sample of the upper foot of a coal bed 3 feet thick, also in sec. 32, contained 0.014 percent equivalent uranium, 0.019 percent uranium, and 0.054 percent uranium in the ash (BONM-11). The strata are deformed from slumping but all samples were collected from strata which are within a few feet stratigraphically of the lower Gibson-Hosta contact.

Outcrops of these rocks were examined at close intervals to the north through Satan Pass on both sides of the Canyon as far as sec. 16, T. 16 N., R. 12 W. but no abnormal radioactivity was noted. An examination was made of the lower Gibson-Hosta contact south of Crown Point in secs. 29 and 30, T. 17 N., R. 12 W. and of the Gallup sandstone in T. 15 N., R. 12 W., but no radioactivity was detected.

The Hosta sandstone forms the caprock of Hosta Butte in secs. 26 and 27, T. 16 N., R. 13 W. The Hosta sandstone and underlying lower Gibson member, which are exposed on the east side of the butte, were examined, but no radioactivity was discovered except near the lower Gibson-Hosta contact. There, a thin stratum of radioactive coaly material which does not exceed 3 inches in thickness, occurs in the lower Gibson member 2½ feet below the lower Gibson-Hosta contact. This material contained 0.012 percent equivalent uranium, 0.013 percent uranium, and 0.033 percent uranium in the ash (BONM-8).

The lower Gibson member and the Hosta sandstone were examined about 8 miles west of Satan Pass near the south entrance to Mariana Pass in sec. 8, T. 16 N., R. 13 W., but no radioactivity was detected. The scarps on both sides of the pass were examined also, but no abnormal radioactivity was noted. In the NE¼, SW¼, sec. 5, T. 16 N., R. 13 W. a lens of carbonaceous shale 1.8 feet thick contained 0.009 percent uranium (BONM-12). In the NW¼, sec. 2, T. 16 N., R. 14 W. a bed of carbonaceous shale 0.7 feet thick contained 0.013 percent equivalent uranium and 0.016 percent uranium (BONM-16). Both of these shale beds are at the lower Gibson-Hosta contact.

The lower Gibson and Hosta rocks were examined in Dalton Pass, about 4 miles west of Mariana Pass. For about 6 miles to the west no radioactivity was detected except at a ridge due north and across the valley from Dalton Pass, approximately in sec. 28, T. 17 N., R. 14 W. There the Hosta sandstone rests directly on a lens of impure coal that is about 3 inches thick and contains 0.025 percent uranium with 0.038 percent uranium in the ash (BONM-15).

Two occurrences of uranium are known in the Dakota hogback about 3 miles east of Gallup. One of these, about 1½ miles north of U.S. Highway 66, is in carbonaceous shale. The other occurrence is more closely associated with sandstone. Because of the association of uranium with carbonaceous material some attention was given to other Upper Cretaceous carbonaceous rocks in this area. Coal and carbonaceous shale in the Gallup, Gibson, and Dilco members of the Mesaverde formations in the northern part of T. 16 N., R. 18 W. and in the northwestern part of T. 16 N., R. 17 W. were examined, but no abnormal radioactivity was detected.

The caprock of Pyramid rock, in the SE$\frac{1}{4}$ sec. 3, T. 15 N., R. 17 W., consists of Dakota sandstone that contains a small quantity of interbedded carbonaceous shale. The shale is slightly radioactive but no samples were collected. Radioactivity was found in a bed of carbonaceous shale 4 feet thick in the Dakota sandstone above Kit Carson's Cave which is about 2 miles east of Pyramid Rock. The upper 1.5 feet of the shale contains 0.012 percent equivalent uranium and 0.008 percent uranium (BONM-17A), and the lower 2.5 feet contained 0.004 percent equivalent uranium (BONM-17B).

Parts of the southern San Juan Basin were surveyed by airborne detection equipment under the direction of J. Meuschke of the Geological Survey. Seven east-west flight lines, each about 25 miles long, were flown in T. 16 N., R. 14 to 18 W. No radioactivity anomalies were recorded.

CHUSKA MOUNTAIN AREA

During the reconnaissance work carried on during 1951, radioactive coal was discovered in the Tocito sandstone of Late Cretaceous age on Beautiful Mountain in San Juan County, New Mexico (Bachman and Read, 1952). Because of this occurrence of uranium-bearing coal, the Chuska Mountain area was examined during the 1952 season. However, exposures in many parts of the Chuska Mountains are too poor for effective reconnaissance with radioactivity detecting instruments.

In a hogback east of Toadlena, the Tocito sandstone contains abundant interbedded carbonaceous material. These rocks were examined carefully from the Newcomb-Toadlena road southward for a distance of about 4 miles to the point where they are covered by Tertiary rocks. The Dakota sandstone and the Todilto limestone also were examined at closely spaced points along the hogback. No abnormal radioactivity was detected.

In Washington Pass, Tertiary igneous rocks are slightly radioactive. A grab sample (BONM-28) of gray tuff contained 0.0037 percent equivalent uranium and 0.0001 percent uranium. A sample (BONM-29) of diabase contained 0.0056 percent equivalent uranium and 0.0005 percent uranium.

Isolated exposures of the Morrison formation and the Todilto limestone were examined east and south of Crystal, but no radioactivty was detected.

MOUNT TAYLOR AND VICINITY

Mount Taylor is flanked by Mesa Chivato, a basalt-capped plateau which extends northward and northeastward for several miles in southeastern McKinley County (Hunt, 1936). Reconnaissance was undertaken along the east side of Mesa Chivato where a relatively thick sequence of Upper Cretaceous strata containing carbonaceous material is well exposed. Upper Cretaceous rocks that crop out east of Mount Taylor include in ascending order, the Dakota sandstone, the Mancos shale, and the Mesaverde formation. In general, these strata dip gently westward into the Mount Taylor syncline.

Coal and carbonaceous material in the lower Gibson member of the Mesaverde formation on the north side of Seboyeta Canyon were examined, but no radioactivity was detected. The line of cliffs from Seboyeta north to Marquez, a distance of about 6 miles, was examined and found to be non-radioactive.

A basalt-capped plateau also extends about 7 miles south from Mount Taylor. The plateau there is terminated by cliffs of Upper Cretaceous rocks that were examined at numerous localities but which are not radioactive. Numerous coal beds are well exposed in a fork of Guadalupe Canyon in sec. 15, T. 11 N., R. 8 W., but no radioactivity was detected.

Upper Cretaceous rocks are poorly exposed near the top of Mount Taylor and were examined but were not found to be radioactive.

GALLINA-COYOTE AREA

The Gallina-Coyote area, Rio Arriba County, is about 53 miles northwest of Santa Fe and 15 miles northeast of Cuba. The topography of the area is extremely varied, altitudes ranging from 6,700 feet at Coyote to more than 10,000 feet on San Pedro Mountain, about 5 miles south of Gallina. Pre-Cambrian metamorphic and igneous rocks, Tertiary igneous rocks, and sedimentary rocks that range in age from Pennsylvanian to Recent are exposed in the area. Most attention was given to rocks of Jurassic and Cretaceous age, although other rocks were examined briefly.

Along New Mexico State Highway 96, between Coyote and Gallina, sedimentary rocks are exposed. Permian "red beds" of the Cutler formation are overlain by the Chinle formation of Triassic age. Jurassic rocks include the Entrada sandstone and the Wanakah and Morrison formations. To the north of the highway, Mesa Alta is capped by the Dakota sandstone of Cretaceous age. To the west of Mesa Alta the stratigraphic sequence includes the Dakota sandstone, the Mancos shale, the Mesaverde formation, the Lewis shale, Pictured Cliffs sandstone, Fruitland-Kirtland formation, the Ojo Alamo sandstone, the Nacimiento group, and the Wasatch formation.

Exposures on Mesa Alta were examined in some detail. Along a line of cliffs at the south end of the mesa the Wanakah and Morrison formations were carefully examined in secs. 13, 14, 15, 22, 23, and 24, T. 23 N., R. 2 E. The Dakota sandstone was examined over much of Mesa Alta. However, slumping and vegetation cover much of the Dakota sandstone and good exposures are rare. No abnormal radioactivity was detected in the Dakota sandstone on Mesa Alta.

A series of hogbacks composed of Cretaceous rocks were examined west of Gallina. Carbonaceous shale and coal in both the Dakota sandstone and the

Mesaverde formation are well exposed at numerous places and were examined at selected points along the hogback for about 14 miles. No radioactivity was detected.

Other places in the Gallina-Coyote area where radioactivity surveys were made include Cerro Pedernal about 6 miles south of Coyote (carbonaceous material in the Dakota sandstone); the north and west sides of San Pedro Mountain (Cutler "red beds"); and Mesa Pinebestosa (the Madera formation). No abnormal radioactivity was detected, and no samples were collected.

CHACRA MESA, McKINLEY COUNTY

Upper Cretaceous and Tertiary rocks in the vicinity of Chacra Mesa, McKinley County (Dane, 1936) were briefly examined during 1952. The stratigraphic section was examined at many places from Crown Point northward to Whitehorse Trading Post, and from there eastward to Cabezon with a scintillation detector. No radioactivity was noted in this area except for a shale at the base of the Ojo Alamo sandstone about 1 mile southeast of Pueblo Bonito National Monument in Chaco Canyon. The shale (BONM-25) contains 0.001 percent equivalent uranium.

HAGEN BASIN, SANDOVAL COUNTY

Brief reconnaissance was done in the Hagen Basin in the southeast part of Sandoval County. Jurassic and Upper Cretaceous sedimentary rocks and Tertiary igneous rocks were examined. The Wanakah formation of Jurassic age was examined north of Golden and at other points on the east side of the Hagen Basin, but no radioactivity was detected. Coal in the Mesaverde formation of Upper Cretaceous age was examined at several localities in the

vicinity of the deserted town of Hagen but is not radioactive. A sill composed of quartz monzonite porphyry was sampled in the NE$\frac{1}{4}$, sec. 4, T. 12 N., R. 6 E. about a quarter of a mile east of the Diamond Trail Ranch house. The sample contained 0.010 percent equivalent uranium and 0.002 percent uranium (BONM-1). The sill intrudes the Mancos shale of Late Cretaceous age. The upper contact of the sill with the Mancos shale was obscured by alluvium; however, shale immediately underlying the sill is baked and slightly radioactive. Two samples of the shale, BONM-2 and BONM-3, contained 0.004 and 0.002 percent equivalent uranium respectively.

SCHOLLE COPPER DISTRICT

The Scholle copper district is in Abo Pass about 13 miles west of Mountainair, Torrance County. Copper minerals are associated with carbonaceous material in the Permian Abo formation. Prospects consisting of several trenches, an adit, and a shaft in a valley about three-fourths of a mile southeast of Scholle were examined for radioactivity. A sample of the most radioactive material observed, an arkose, contained 0.016 percent equivalent uranium and 0.008 percent uranium (BONM-19). The zone from which this sample was collected could not be followed because of a cover of alluvium. The Abo formation was examined from this point northward towards the south end of the Manzano Mountains for about 10 miles. Numerous abandoned copper mines and prospects were examined, but no abnormal radioactivity was detected.

CUBA MESA AREA

Cuba Mesa is 2 miles west of Cuba in Sandoval County. Rocks exposed on Cuba Mesa are of Tertiary age and are divided into two major units. The lower unit, the Nacimiento group, consists of 400 to 800 feet of shale and

and sandstone. The upper unit, the Wasatch formation, is approximately 1,000 feet in thickness and is composed of sandstone, shale, and conglomerate. The lower part of the Wasatch formation forms the caprock of Cuba Mesa, where it is about 200 feet thick.

The Wasatch formation was examined about 1½ miles north of Cuba along New Mexico State Highway 44, where carbonaceous shale and fragments of fossil wood were found to be radioactive. A sample of carbonaceous siltstone (BONM-20) contained 0.012 percent equivalent uranium and 0.002 percent uranium.

Exposures on Cuba Mesa were examined along the south and southwest part of the mesa in secs. 1, 2, and 10, T. 20 N., R. 2 W., and secs. 33 and 36, T. 21 N., R. 2 W. At a few localities sediments near the base of the cliff-forming Wasatch formation contained radioactive carbonaceous material. A sample of a sandstone near the base of the Wasatch formation in the NW¼, sec. 1, T. 20 N., R. 2 W. contained 0.006 percent equivalent uranium and 0.003 percent uranium (BONM-22). Talus has covered most of the zone where radioactivity has been found on Cuba Mesa; consequently an adequate appraisal could not be made of the potentialities of this area.

SAN ACACIA AREA

The Datil formation in the San Acacia area, Socorro County, consists of rhyolite, tuffaceous sandstone and clay, and conglomerate made up of volcanic rocks. A cobble (BONM-31) from a conglomerate in the Datil formation about 7 miles west of U.S. Highway 85 and about a mile south of the Rio Salado, contained 0.0042 percent equivalent uranium and 0.0002 percent uranium. The cobbles in the conglomerate here appear to be somewhat more basic in composition than in the Datil formation at other places. A sample (BONM-32) of a

white tuffaceous sandstone about half a mile south of the outcrop of conglomerate contained 0.0022 percent equivalent uranium and 0.0001 percent uranium. A sample (BONM-33) from a 1-foot clay bed overlain by the sandstone contained 0.0009 percent equivalent uranium and 0.0001 percent uranium.

GALLUP-ZUNI BASIN

A sample (BONM-26) of tuff of Tertiary age was collected about 15 miles south of Gallup, McKinley County, in a road cut on New Mexico State Highway 32. It contained 0.0051 percent equivalent uranium and 0.0003 percent uranium.

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APPENDIX

Field number	Lab. number	Rock type	Equivalent uranium (percent)	Uranium (percent)	Uranium in ash (percent)	Notes
Southern edge of San Juan Basin, McKinley County						
BONM-4	87743	Shale	0.007	0.008		Channel sample of 1.3' shale; NW¼, sec. 24, T. 14 N., R. 9 W. Immediately below Hosta-lower Gibson contact.
BONM-5	87744	Coal	0.038	0.035		Coal lenticle 3 inches thick selected from 1.3' channel sample BONM-4.
BONM-13	87752	Sandstone	0.005	0.002		Hosta ss. immediately above channel sample BONM-4.
BONM-6	87745	Siltstone and shale	0.020	0.014		N½, sec. 14, T. 14 N., R. 9 W.; shale and silty zone in Hosta ss. (at base). 5" thick.
BONM-7	87746	Shale	0.008	0.007		Grab sample 85' west of BONM-6. At lower Gibson-Hosta contact.
BONM-14	87753	Shale	0.014	0.005		Chip sample SW¼, sec. 12, T. 14 N., R. 9 W., 1 foot shale at base of Hosta ss.
BONM-9	87748	Coal	0.003	0.005	0.034	Channel sample, coal 1 foot thick. N½, sec. 32, T. 16 N., R. 12 W.
BONM-10	87749	Carb. shale	0.003			Grab sample carb. shale associated with BONM-9.
BONM-11	87750	Coal	0.014	0.019	0.054	Upper 1' of 3' bed. In slumped material near BONM-9.
BONM-8	87747	Coal	0.012	0.013	0.033	Impure coal 0.1' thick. 2.4' below base of Hosta ss. Hosta Butte, SW¼, sec. 26, T. 16 N., R. 13 W.

APPENDIX (CONT.)

Field number	Lab. number	Rock type	Equivalent uranium (percent)	Uranium (percent)	Uranium in ash (percent)	Notes
Southern edge of San Juan Basin, McKinley County (Cont.)						
BONM-12	87751	Carb. shale	0.008	0.009		
BONM-16	87755	Carb. shale	0.013	0.016		Carb. shale 0.7' thick at basal contact of Hosta ss. on point to west of Mariana Pass.
BONM-15	87754	Coal	0.022	0.025	0.038	Impure coal 0.2' thick on ridge due north and across valley from Dalton Pass.
BONM-17A	87756	Shale	0.012	0.008		Upper 1.5' of 4' carb. shale near base of Dakota ss. above Kit Carson's Cave.
BONM-17B	87757	Shale	0.004			Lower 2.5' of 4' carb. shale. Same locality as BONM-17A.
Chuska Mountain area						
BONM-28	D-75652	Tuff	0.0037	0.0001		Tuff at top of Washington Pass.
BONM-29	D-75653	Diabase	0.0056	0.0005		
BONM-27	D-75651	Tuff	0.0049	0.0002		In road cut west of Toadlena; may be in Chuska ss.
BONM-30	D-75654	Clay	0.0006	0.0001		
Chacra Mesa						
BONM-25	101936	Carb. shale	0.001			

APPENDIX (CONT.)

Field number	Lab. number	Rock type	Equivalent uranium (percent)	Uranium (percent)	Uranium in ash (percent)	Notes
Hagen Basin						
BONM-1	87740		0.010	0.002		
BONM-2	87741	Shale	0.004			Mancos shale contacting sill (BONM-1).
BONM-3	87742	Shale	0.002			Mancos shale below contact with sill.
Scholle Copper district						
BONM-19		Arkose	0.016	0.008		
Cuba Mesa area						
BONM-20	D-72617	Carb. siltstone	0.012	0.002		
BONM-22	D-72618	Sandstone	0.006	0.003		
San Acacia area						
BONM-31	D-76582	Andesite (?)	0.0042	0.0002		
BONM-32	D-76583	Tuffaceous sandstone	0.0022	0.0001		
BONM-33	D-76584	Clay	0.0009	0.0001		
Gallup-Zuni basin						
BONM-26	D-75650	Tuff	0.0051	0.0003		

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Dear Phil:

Transmitted herewith are six copies of Trace Elements Memorandum Report 443, "Trace elements reconnaissance investigations in New Mexico and adjoining states in 1951," by George O. Bachman and Charles B. Read, October 1952.

Uranium in possible commercial amounts was found at La Ventana Mesa, Sandoval County, New Mexico. These deposits and the plans for their further investigation are discussed in TEI-241, which is in preparation and should be transmitted soon.

Slightly uraniferous coal and carbonaceous shale were found near San Ysidro, Sandoval County, and Beautiful Mountain, San Juan County, New Mexico, and at Keams Canyon, Navajo County, and near Tuba City, Coconino County, Arizona. None of these occurrences appear to be of immediate economic importance, but additional reconnaissance has been under way this field season in these general areas.

Sincerely yours,

for W. H. Bradley
Chief Geologist

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TRACE ELEMENTS RECONNAISSANCE INVESTIGATIONS IN NEW MEXICO AND ADJOINING STATES IN 1951*

By

George O. Bachman and Charles B. Read

October 1952

Trace Elements Memorandum Report 443

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TRACE ELEMENTS RECONNAISSANCE INVESTIGATIONS IN NEW MEXICO AND ADJOINING STATES IN 1951

By George O. Bachman and Charles B. Read

ABSTRACT

In the summer and fall of 1951, a reconnaissance search was made in New Mexico and adjacent states for uranium in coal and carbonaceous shale, chiefly of Mesozoic age, and black marine shale of Paleozoic age. Tertiary volcanic rocks, considered to be a possible source for uranium in the coal and associated rocks, were examined where the volcanic rocks were near coal-bearing strata.

Uranium in possibly commercial amounts was found at La Ventana Mesa, Sandoval County, N. Mex. Slightly uraniferous coal and carbonaceous shale were found near San Ysidro, Sandoval County, and on Beautiful Mountain, San Juan County, all in New Mexico, and at Keams Canyon, Navajo County, and near Tuba City, Coconino County, in Arizona. Except for the La Ventana deposit, none appeared to be of economic importance at the time this report was written, but additional reconnaissance investigations have been underway this field season, in the areas where the deposits occur.

Marine black shale of Devonian age was examined in Otero and Socorro Counties, New Mexico and Gila County, Arizona. Mississippian black shale in Socorro County and Pennsylvanian black shale in Taos County, New Mexico also were tested. Equivalent uranium content of samples of these shales did not exceed 0.004 percent.

Rhyolitic tuff from the Mount Taylor region is slightly radioactive as is the Bandelier tuff in the Nacimiento region and in the Jemez Plateau. Volcanic rocks in plugs and dikes in the northern Chuska Mountains and to the north in New Mexico as well as in northeastern Arizona and southeastern Utah are slightly radioactive. Coal and carbonaceous rocks in the vicinity of these and similar intrusions are being examined.

INTRODUCTION

During 1951 the writers made a geologic reconnaissance of portions of New Mexico and adjoining states in search of uranium, primarily in black shales and carbonaceous rocks and in an effort to evaluate the potentialities of certain regions for uranium prospecting in the future. This work was done on behalf of the Atomic Energy Commission. Various reconnaissance radiometric techniques were used in the search for uranium in each region as each offered different geologic problems. Carborne radiometric equipment was used to traverse extensive areas with the objective of eliminating negative areas. Carborne equipment could not be taken into certain areas but regions which showed relatively high background gamma ray count--indicating that bodies of disseminated radioactive elements were present--were examined in more detail for possible local concentrations of minerals. Inaccessible areas were traversed as frequently as possible on foot with portable Geiger counters.

Instruments used in geologic reconnaissance consisted of a carborne gamma ray counter equipped with two 46-inch Geiger-Mueller cathode tubes, a portable gamma ray counter equipped with a 24-inch Geiger-Mueller cathode tube, portable gamma-beta counters of the Nuclear type, and a Berkeley scaler. The carborne counter and the portable 24-inch cathode tube were used to locate areas of high background gamma ray count (i.e. rock types containing minute but abnormal quantities of radioactive elements).

GENERAL CONSIDERATIONS

It is the writers' belief that, to be most effective, reconnaissance for uranium deposits must be considered in connection with the framework of the geology of the region. Areas judged most likely to contain deposits of uranium, based on the present knowledge of the geologic conditions under which uranium occurs, should be examined first and in the greatest detail. Seemingly less favorable areas then should be considered.

Particular attention has been given to the search for rock types which contain disseminated radioactive elements. This search has been stimulated by the possibility that locally, under favorable geologic conditions, radioactive minerals may be concentrated from such disseminated bodies. Thus, volcanic rocks,

tuffaceous sediments, and arkose often contain small amounts of uranium which could be concentrated by geologic agents in favorable receptor rocks.

Receptor rocks include:

1. Carbon and carbonaceous materials, such as coal and carbonaceous shale, probably adsorb or otherwise concentrate the uranyl ion (Tolmachev, 1943). Hence they are suitable receptors for the concentration of uranium carried by ground water, either past or present.

2. Clay minerals of relatively large space lattice may concentrate uranium through ionic exchange or adsorption (Frederickson, 1948).

In addition to the above receptor materials limestone may be of some importance in the concentration of uranium. Notestein (1918) has stated that "calcite readily precipitates vanadium and uranium from vanadyl and uranyl sulphate solutions."

The distribution of coal and carbonaceous rocks in New Mexico is relatively well known, as are the broad outlines of the chief areas of volcanic flows, tuffs, and associated materials. Where volcanic rocks and tuffs are concerned, it is necessary also to consider the probable former extent of the potential source rocks as well as their present distribution. The places where receptor rocks and possible source rocks are associated were examined first.

REGIONS[1/] INVESTIGATED

Carbonaceous beds were examined in eight regions during the 1951 field season. Most of the regions contained extrusive igneous rocks or were adjacent to igneous activity. These include the following (figs. 1 and 2):

1. Datil Mountain region
2. Zuni-Gallup Basin region

1/In the present discussion region refers to a geographic area of rather broad extent. Area refers to a portion of a region, and locality refers to individual outcrops or lines of outcrop within an area. Areas described in this report do not necessarily fall within the confines of previous mapping projects.

3. Carthage, Sierra Blanca, and Engle regions
4. Mount Taylor region including the San Mateo area
5. San Ysidro and La Ventana areas in the Nacimiento region
6. Chuska Mountain region
7. Black Mesa region
8. Miscellaneous areas

Marine black shale bodies of various ages were examined at a number of localities and sandstone-type copper deposits were examined where present in the regions studied.

Datil Mountain region, New Mexico

The Datil Mountain region in Socorro, Catron, and Valencia Counties, New Mexico, has been mapped and described by Winchester (1921). Cretaceous coal-bearing strata of Mesaverde age are overlain locally by the Tertiary Datil formation. The Mesaverde strata consist of interbedded sandstone, shale, and subbituminous coal. The coal beds are relatively thin and lenticular. The Datil formation is composed of conglomerate, and andesitic and rhyolitic tuff. The Datil formation was checked radiometrically in the field at numerous localities but no abnormal radioactivity was observed. Coal beds were checked radiometrically throughout the stratigraphic section in Jaralosa Canyon and at positions high in the stratigraphic section in Red Canyon with negative results. As radioactivity was not noted, no samples were collected in the Datil Mountain region.

Zuni-Gallup Basin region, New Mexico

The Zuni-Gallup Basin in Valencia and southern McKinley Counties, New Mexico, has been mapped and described by Sears (1925). Interbedded sandstone, shale, and subbituminous coal of the Mesaverde

formation of Upper Cretaceous age is present over most of the region. McCann (1938) has described Tertiary sediments with white tuff and bentonitic clay resting unconformably on the Mesaverde formation in the Zuni Basin. The tuffaceous material was examined by the writers at several points along New Mexico State Highway 32 between Gallup and Zuni. Coal beds a few feet stratigraphically below the erosional unconformity were also examined. Abnormal radioactivity was not found in either the tuff or the coal and no samples were collected.

Carthage, Sierra Blanca, and Engle regions, New Mexico

The Carthage, Sierra Blanca, and Engle regions in Socorro, Lincoln, and Sierra Counties, New Mexico, were examined briefly. Basic igneous intrusions of Tertiary age are in close association with carbonaceous and coal-bearing strata of Upper Cretaceous age. Abnormal radioactivity was not observed in either the igneous rocks or the carbonaceous beds. One sample (Sample 17) from a carbonaceous shale in the Upper Cretaceous about 5 miles east of Engle contained 0.002 percent equivalent uranium, which is not considered significant.

Mount Taylor region, New Mexico

A slightly radioactive tuff is widespread in the Mount Taylor region in McKinley and Valencia Counties, New Mexico. The tuff is a potential source for radioactive elements; carbonaceous beds in the Dakota sandstone and the Mesaverde formation may be important factors in the concentration of uranium derived from the tuff. The geology of the Mount Taylor region has been described by Gardner (1910) and by Hunt (1936, 1937).

Hunt (1937, p. 58) attributes the tuff to the earliest period of eruption of Mount Taylor and describes it as a rhyolitic tuff that is distinctly bedded. Other types of volcanic rocks are also present. The tuff is well exposed in the Grants Ridges about 3 miles northeast of the town of Grants where a pumice mine is now being operated. The tuff is also exposed at numerous points around La Jara Mesa in the San Mateo area and on the north end of Horace Mesa. Three samples of the tuff (Samples O, 19, 20) were collected

at the mine north of Grants. The samples contained from 0.002 to 0.003 percent equivalent uranium and 0.001 percent uranium. Clayey material (Sample 21) collected from a playa in the canyon below the pumice mine contains 0.004 percent equivalent uranium and 0.002 percent uranium. These percentages are significant in that they indicate the presence of disseminated uranium in the Mount Taylor region. The tuffaceous material is porous and permeable which makes it readily susceptible to leaching by ground water solutions. Under favorable geologic conditions the disseminated uranium may be concentrated in rock units in close proximity to the present, or past, distribution of the tuff.

Cretaceous carbonaceous rocks and coal have been examined radiometrically at numerous points in the Mount Taylor region with negative results. At the places examined so far, however, the rocks between the carbonaceous material and the tuff have so little porosity and permeability that ground water could not readily carry mineral-bearing solutions into the carbonaceous material. At least 2,000 feet of argillaceous sediments is present between the tuff and the carbonaceous material. Coal (Sample 18) in Lobo Canyon, west of Mount Taylor, contained only 0.003 percent uranium in the ash of the coal. Samples 18 to 23 were collected in the Mount Taylor region.

Additional work in the Mount Taylor region will be aimed at finding carbonaceous material located favorably in relation to potential source rocks.

Nacimiento region, New Mexico

Mesaverde and Dakota sediments of Cretaceous age, containing coal and carbonaceous shale, crop out in the San Ysidro area in the southern portion of the Nacimiento region, Sandoval County, New Mexico (Hunt, 1936). The northern limits of the area are about 3 miles south of the town of San Ysidro. Pumiceous sediments of the Tertiary Santa Fe formation are exposed just east of the area and may have supplied radioactive elements which could have been concentrated in the carbonaceous Cretaceous sediments. Only minor radioactivity has been found in the San Ysidro area. A bed of coal 1.9 feet in thickness (Sample 25) in the Mesaverde formation contains 0.004 percent uranium in the ash. Samples 24-27 and 41-42 were collected in the San Ysidro area.

The La Ventana area in the southern part of the Nacimiento region is located just west of the highly folded and faulted pre-Cambrian and Paleozoic rocks in the Sierra Nacimiento. The geology of the area has been described by Renick (1931), Dane (1936), and Wood and Northrop (1946). Coal occurs in rocks of Mesaverde age in the vicinity of La Ventana. On the eastern flank of the Sierra Nacimiento the Bandelier tuff of Pleistocene (?) age caps many of the higher mesas. The Bandelier tuff is also widespread on the Jemez volcanic plateau to the east of the Sierra Nacimiento. The tuff contains as much as 0.006 percent equivalent uranium and 0.003 percent uranium (Samples 95, 96). The La Ventana area seemed favorable for the occurrence of uraniferous coal because of the possibility that the Bandelier tuff formerly lapped westward across the Sierra Nacimiento and thus supplied uranium which could be concentrated in the carbonaceous rocks of the Mesaverde formation.

Additional reconnaissance in the eastern part of the Nacimiento region will aim at finding other deposits of carbonaceous rocks favorably located in relation to the Bandelier tuff on the Jemez plateau.

Uranium was found in coal and carbonaceous shale in the Allison member of the Mesaverde formation on La Ventana Mesa in August, 1951, (Bachman and Read, 1951). Uranium was also found east of La Ventana Mesa in carbonaceous beds in the Gibson coal member of the Mesaverde formation and in the Dakota sandstone (Read, 1952). The coal on La Ventana Mesa contains as much as 0.62 percent uranium with 1.34 percent uranium in the ash. The La Ventana deposits are described in detail and with plans for further work by Vine, Bachman, Read, and Moore (1952, TEI-241, in preparation).

Chuska Mountain region, New Mexico and Arizona

Upper Cretaceous strata bearing coal and carbonaceous rocks are widespread in the Chuska Mountain region at San Juan County, New Mexico and Apache County, Arizona and the adjacent San Juan Basin in New Mexico. Volcanic rocks of Tertiary age are intimately associated with the Cretaceous strata. The volcanic rocks occur chiefly in plugs and are usually of basic composition. However, Gregory (1917, p. 81) has reported rhyolitic ash in the Chuska sandstone of Tertiary age.

The portion of the Chuska Mountain region examined is on the western flank of the San Juan structural basin. On Beautiful Mountain, (fig. 3) strata of Mesozoic age dip eastward into the basin from the northern extension of the Defiance uplift which bounds the San Juan Basin on the west. The Mesozoic rocks are truncated and overlain by the Chuska sandstone and other rocks and volcanic debris of Tertiary age.

Minor radioactivity was detected in carbonaceous sediments and coal of Upper Cretaceous age on Beautiful Mountain. The Upper Cretaceous Tocito sandstone includes a zone of carbonaceous material and coal at its top. Where the carbonaceous material is near the erosional surface upon which the Tertiary sediments were deposited, minor radioactivity was detected at many places. On Beautiful Mountain, the upper half of a bed of coal 1.3 feet thick contains 0.007 percent uranium (Sample 103). Immediately below a joint in the overlying strata the same bed contains 0.010 percent uranium with 0.021 percent uranium in the ash (Sample 102). Other carbonaceous material about 150 feet stratigraphically and topographically below the points sampled contained no abnormal radioactivity.

Slightly abnormal radioactivity was detected in many volcanic plugs and their associated dikes. Radioactivity was estimated to be 0.003 percent equivalent uranium. At several localities on Beautiful Mountain and on Lukachukai Mountain to the west, the Tertiary rocks and volcanic debris contain slight radioactivity. The Tertiary rocks and volcanic material thus seem to be potential source beds for secondary accumulation of uranium in the coal and carbonaceous rocks.

These Tertiary rocks and volcanic debris having slight radioactivity cap both Lukachukai Mountain and Cove Mesa and might be the source of the uranium in the Morrison formation at these places. This possibility probably would be of little importance in the exploration of the Morrison formation in that area but it should be considered in connection with any age determinations made on the Morrison ores of that area.

Black Mesa region, Arizona

The Black Mesa region (fig. 4) covers an area of about 3,000 square miles in Navajo, Apache, and eastern Coconino Counties, Arizona. Sedimentary rocks of Dakota (?) and Mesaverde age cap the mesa at most places. Coal and carbonaceous shale are prominent in these rocks. Hack (1942) has described the Bidahochi formation, which contains volcanic material, resting on Cretaceous and older deposits in the Black Mesa-Hopi Buttes regions. Both the Cretaceous carbonaceous sediments and the Bidahochi formation have been examined radiometrically. No abnormal radioactivity has been detected in the Bidahochi formation; however, minor radioactivity has been noted in carbonaceous material and natural coal ash on Black Mesa. At the Keams Canyon locality (Sample 111 and fig. 4) a coal bed 2.0 feet thick contains 0.004 percent equivalent uranium and 0.002 percent uranium. At the Tuba City coal mine, about 10 miles east of Tuba City, a natural ash contains 0.004 percent uranium (Sample 114 and fig. 4).

Miscellaneous areas

Other areas visited during the 1951 field season include the following:

1. Walsenburg area, Huerfano County, Colorado. Volcanic plugs intrude strata of Cretaceous and Tertiary age. Several acidic plugs in the vicinity of Walsenburg showed slightly abnormal radioactivity. R. B. Johnson collected a sample from the Pierre shale of Cretaceous age which showed slight radioactivity (Sample 105). The sample was collected in the contact zone of the Pierre shale with a dark igneous dike.
2. Pecos area, Santa Fe County, New Mexico. Coal of Pennsylvanian age in the Pecos Valley was examined but no abnormal radioactivity was detected.
3. Sage Plains, Montezuma County, Colorado, and San Juan County, Utah. Coal in the Dakota sandstone was examined at a number of localities along U. S. Highway 160 between Cortez, Colorado, and Monticello, Utah, but no abnormal radioactivity was detected.

4. Asphaltic sandstone of Triassic age (Santa Rosa sandstone) about 9 miles northeast of Santa Rosa, Guadalupe County, New Mexico, was examined radiometrically but with negative results.

5. Sandstone-type copper deposits. Numerous sandstone type copper deposits were examined. Minor radioactivity was detected in most of these deposits. The deposits are described in greater detail by Bachman and Read (1952).

MARINE BLACK SHALE

Marine black shale of Devonian, Mississippian, and Pennsylvanian age was examined at several localities in New Mexico and Arizona. Equivalent uranium content did not exceed 0.004 percent in any of the samples collected. Localities visited included black shale in the Madera formation of Pennsylvanian age near Tres Ritos, Taos County, New Mexico (Sample 1); Percha shale (fig. 1) of upper Devonian age in Otero and Socorro Counties, New Mexico (Samples 7-15); shale in the Lake Valley limestone of Mississippian age in Socorro County, New Mexico (Sample 16); and the upper shaly portion of the Martins limestone of Devonian age in Gila County, Arizona (Samples 106-109). Analyses of these samples are given in the appendix.

RADIOACTIVE VOLCANIC ROCKS

Radioactivity detected in volcanic rocks examined in this study was not restricted to a narrow range of petrologic types, but was detected more consistently in acidic volcanic rocks than in basic ones. The acidic Bandelier tuff of Pleistocene (?) age on the Jemez volcanic plateau and the rhyolitic tuff in the Mount Taylor region showed minor abnormal radioactivity at most places. However, the Abiquiu formation, an acidic volcanic tuff of early Tertiary age at the north end of the Jemez volcanic plateau, and a Tertiary acidic tuff in the Zuni basin were not radioactive.

Most dark volcanic rocks examined contained no radioactivity which was detectable in the field; however breccia and minette in volcanic plugs, such as Ship Rock, Mitten Butte, Ford Butte, and Bennett

Peak in San Juan County, New Mexico and Agathla Peak and similar bodies in Monument Valley, Arizona and Utah, (Williams, 1936) contain slightly abnormal radioactivity. The relatively high potassium content of minette does not appear to be sufficient to account for the radioactivity of the plugs as Twin Cones, near Gallup, New Mexico, contains a similar minette which shows no radioactivity. Several monchiquite volcanic plugs in the Hopi Buttes region were examined but were not radioactive.

PLANS

Areas in which abnormal radioactivity was detected during 1951 in coals and carbonaceous shales and potential source rocks in New Mexico and Arizona are being examined by the Survey in reconnaissance fashion this year. The areas in which the work is being concentrated and the occurrences there of abnormal radioactivity are summarized below.

1. The east flank of the Chuska Mountains, San Juan County, New Mexico from Chuska Valley southward to the vicinity of Washington Pass, including Beautiful Mountain where one sample from a coal bed in the Tocito sandstone contained 0.007 percent uranium. A brief airborne radiometric survey was made during September 1952 and, although the detailed results are not yet available, one anomaly of possible interest was found. Exposures of coal and carbonaceous shale are poor and the ground reconnaissance is being made with the most sensitive radiometric instruments available.

2. The Mount Taylor-Mesa Chivato region contains slightly uraniferous volcanic rocks resting on coal-bearing Cretaceous strata. The coal and carbonaceous rocks are being examined in detail. An important part of the investigation in this area is the study of the regional geology of the tuff to determine as far as possible the former extent of the tuff to focus attention on areas where carbonaceous rocks once were overlain by it.

3. Mesa Prieta, Sandoval County, New Mexico consists of Cretaceous coal-bearing strata capped by volcanic rocks. Little is known of the volcanic rocks but Mesa Prieta is about half way between the Mount Taylor-Mesa Chivato region and the Jemez volcanic plateau, where slightly radioactive volcanic rocks occur.

Exposures in the vicinity of Mesa Prieta are poor and reconnaissance radiometric examination is being made with the most sensitive instruments available. An airborne radioactivity survey will be made if feasible.

4. Chacra Mesa, McKinley County, New Mexico, consists of coal-bearing rocks that may once have been overlain by volcanic rocks. Preliminary reconnaissance is being undertaken.

5. The Black Mesa region contains coal-bearing rocks, and a natural coal ash at the Tuba City mine contains 0.004 percent uranium. Possible sources of the uranium have not been recognized. Some coal beds in the nearby areas could be mined by stripping and other strippable coal beds probably exist in the Black Mesa region. Coal beds and carbonaceous rocks are being examined wherever possible. In addition, reconnaissance is being continued in the Jemez Plateau and in the Nacimiento region.

Plans for work on La Ventana Mesa, Sandoval County are given in detail in TEI-241 (in preparation). Throughout the reconnaissance, data on volcanic rocks are being gathered. These data will contribute to knowledge of petrologic types of volcanic rocks containing disseminated uranium, the areal extent of these types, and the natural conditions under which uranium could be released from them.

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APPENDIX

Samples collected for laboratory analysis, 1951

Sample Number	eU Percent	U Percent	Ash Percent	U in ash Percent	Location and Remarks
BNM-0	0.0026	0.0010			Pumice, mine ca. 5 miles north Grants, N. Mex.
1	0.002	0.001			Bituminous shale, marine Pennsylvanian (Madera fm), 1.9 miles east of Taos-Mora County line on N. Mex. State Hwy. No. 3
2	0.012	0.010			Coyote Mining Dist., Mora County, N. Mex. Carbonaceous shale associated with sandstone-type copper deposit, Sangre de Cristo fm. (Permian)
3	0.006	0.004			Tailings from prospect pit, Coyote Mining Dist.
4	0.010	0.009			Tailings from prospect pit, Coyote Mining Dist.
5	0.003	0.001			Guadalupe mine, Guadalupe Co., N. Mex. Carbonaceous shale associated with sandstone-type copper deposit. Santa Rosa sandstone, Triassic
6	0.002	0.002			Guadalupe mine, carbonaceous material in sandstone
7	Less than .001				Base of Percha shale (Devonian) Alamo Canyon, Otero Co., N. Mex.
8	.004	.002			Calcareous zone in Percha shale, ca. 15 feet above base, Alamo Canyon
9	0.004	0.002			Calcareous zone in Percha shale, ca. 22' above base, Alamo Canyon
10	0.003				Percha shale, Alamo Canyon, Basal 3' of 6' shaly unit
11	0.002				Percha shale, Alamo Canyon, Upper 3' of 6' shaly unit
12	0.001				Percha shale, Alamo Canyon, Nodular unit below contact with Lake Valley limestone (Miss.)
13	0.001				Percha shale, 20' from base, Rhodes Pass, San Andres Mts., Socorro County, N. Mex.
14	0.001				Percha shale, 20' unit above No. 13

Samples collected for laboratory analysis, 1951--Continued

Sample Number	eU Percent	U Percent	Ash Percent	U in ash Percent	Location and Remarks
BNM-15	0.001				Percha shale, 10' unit above No. 14
16	0.002				Calcareous shale, in Lake Valley limestone (Miss.) Rhodes Pass
17	0.002				Carbonaceous shale, Mesaverde fm. (Cret.) ca. 5 miles east of Engle, Sierra Co., N. Mex.
18	0.001	0.001	31.0	0.003	Coal, Mesaverde fm. (Cret.) Lobo Canyon west of Mt. Taylor, Valencia Co., N. Mex.
19	0.002	0.001			Pumice, mine ca. 5 miles north Grants, [illegible] Valencia Co., N. Mex.
20	0.003	0.001			Pumice, mine ca. 5 miles north Grants, N. Mex.
21	0.004	0.002			Clay, playa below pumice mine, 5 miles north Grants, N. Mex.
22	0.002				Carbonaceous shale parting, Dakota sandstone (Cret.), 3 miles north Prewitt, Valencia Co., N. Mex.
23	0.002				Carbonaceous shale parting, Dakota sandstone (Cret.), 5 miles north of Grants, N. Mex.
24	Less than 0.001				Santa Fe fm. (Pliocene), pumiceous, 3 miles south San Ysidro, Sandoval Co., N. Mex.
25	Less than 0.001	.001	33.2	0.004	Coal, Mesaverde fm., San Ysidro coal field, Sandoval Co., N. Mex.
26	0.001	0.001			Clay, overlying No. 25
27	0.002				Shale, overlying No. 26
28	0.004	0.005			Aggregate of rock types, Spanish Queen mine, Abo fm. (Permian), Jemez Canyon, Sandoval Co., N. Mex.
29	0.007	0.006			Carbonaceous shale, Spanish Queen mine
30	0.009	0.009			Carbonaceous shale, Spanish Queen mine
31	0.005	0.006			Sandy carbonaceous shale, Spanish Queen mine
32	0.007	0.009			Copper mineralized zone, Spanish Queen mine

Samples collected for laboratory analysis, 1951--Continued

Sample Number	eU Percent	U Percent	Ash Percent	U in ash Percent	Location and Remarks
BNM-33	0.007	0.008			Copper mineralized zone, Spanish Queen mine
34	0.004	0.003			Copper mineralized zone, Spanish Queen mine
35	0.007	0.009			Carbonaceous shale, outcrop adjacent to Spanish Queen mine
36	0.019	0.015			Pod-like mass, copper mineralized zone, Spanish Queen mine
37	0.006	0.005			Copper mineralized zone, Agua Zarca sandstone (Triassic Senorito Dist., Sandoval Co., N. Mex.
38	0.005	0.005			Copper mineralized zone, Abo fm. (Permian) Piedras Negras Canyon, Sandoval Co., N. Mex.
39	0.002	0.003			Copper mineralized zone, Poleo sandstone (Triassic) Cobre Wash, Rio Arriba Co., N. Mex.
40	0.003	0.002			Carbonaceous shale in Wanakah fm. (Jurassic), Butte 2 1/2 miles south of Coyote, Rio Arriba Co., N. Mex.
41	0.002				Carbonaceous shale in Dakota sandstone (Cret.). San Ysidro coal field, Sandoval Co., N. Mex.
42	0.001	0.001			Carbonaceous shale in Dakota sandstone. Below No. 41

Note: Samples 43-92 included in Trace Elements Investigations Report 241 (Vine, Bachman, Read, Moore)

93	0.006				Rat excreta associated with Bandelier tuff, Jemez volcanic plateau, Sandoval Co., N. Mex.
94	0.005				Tuff, same locality as No. 93
95	0.006	0.003			Bandelier tuff (Tertiary), Rio Las Vacas Canyon, Sandoval County, N. Mex.
96	0.003	0.003			Bandelier tuff, Jemez Canyon, Sandoval County, N. Mex.

Note: Samples 97-101 included in another report. (Vine, Bachman, Read, Moore).

Samples collected for laboratory analysis, 1951--Continued

Sample Number	eU Percent	U Percent	Ash Percent	U in ash Percent	Location and Remarks
BNM-102	0.010	0.010	45.5	0.021	Coal, Tocito sandstone, (Cret.), Beautiful Mountain, San Juan County, N. Mex.
103	0.006	0.007	56.1	0.013	Coal and bone, Tocito sandstone, Beautiful Mountain
104	0.002	0.002			Iron stained Tocito sandstone, Beautiful Mountain
105	0.002	0.002			Pierre shale (Cret.) associated with basaltic dike, Huerfano County, Colo.
106	0.004	Less than 0.001	93.2	Less than 0.001	Lower 5' of 20' shale in Martin limestone (Devonian) Gila County, Ariz.
107	0.004	Less than 0.001	91.0	Less than 0.001	Second 5' above 106
108	0.003		88.4		Third 5' above No. 107
109	0.004	Less than 0.001	87.8	Less than 0.001	Top 5' above No. 108
110	0.002		91.5		Carbonaceous shale, Cretaceous, Deer Creek coal field, Gila Co., Ariz.
111	0.004	0.002	79.0	0.003	Carbonaceous shale, Cretaceous, Keams Canyon, Navajo Co., Ariz.
112	0.004	0.002	91.5	0.002	Carbonaceous shale and stone above No. 111
113	0.003	0.002	97.8	0.002	Natural ash, upper 1' of 2' Tuba City coal mine, Coconino County, Ariz.
114	0.005	0.001	93.9	0.004	Natural ash, below No. 113
115	0.002	0.001	42.5	0.002	Bony coal 5.5' below No. 114

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UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

GEOPHYSICAL OBSERVATIONS IN PARTS OF THE GRANTS DISTRICT, McKINLEY COUNTY, NEW MEXICO*

By

Kenneth L. Cook and Calvin K. Moss

August 1952

Trace Elements Investigations Report 244

This preliminary report is distributed without editorial and technical review for conformity with official standards and nomenclature. It is not for public inspection or quotation.

*This report concerns work done on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission

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GEOPHYSICAL OBSERVATIONS IN PARTS OF THE GRANTS DISTRICT, McKINLEY COUNTY, NEW MEXICO

By

Kenneth L. Cook and Calvin K. Moss

ABSTRACT

Geophysical observations near Haystack Mesa in the Grants district, McKinley County, New Mexico, had the dual objective of investigating the unusual occurrence of negative aeromagnetic anomalies in close association with airborne radioactivity anomalies, and of investigating other geophysical methods which might assist directly or indirectly in the search for uranium ores in the Grants district. Ground magnetometer tests indicate the apparent correlation shown in the airborne data is fortuitous.

Ground magnetometer and self-potential surveys on an experimental basis may be justified to test the applicability of these methods in future exploration. Aeromagnetic surveys would aid field geologic studies in locating concealed Tertiary intrusives, which may have affected ore localization.

Continuation of the airborne radiometric survey of the Todilto limestone outcrop is recommended to search for promising areas that might contain additional deposits.

INTRODUCTION

In a combined airborne radioactivity and aeromagnetic survey in the vicinity of Grants, New Mexico, made by the U. S. Geological Survey on May 28, 1951, an unusual association of radioactivity and negative magnetic anomalies was noted (Stead, 1951). As it was thought that this association might reflect a genetic relationship between the uranium mineralization and the geologic structure causing the negative magnetic effect, further investigation seemed advisable.

On December 12 and 13, 1951, field examinations were made in secs. 19 and 25, T. 13 N., R. 10 W., N. M. B. and P. M., McKinley County, New Mexico. Brief ground magnetometer tests were also made in sec. 19. The magnetometer test area lies about 1 mile south of Haystack Mesa, about 6 miles north-northeast of the village of Bluewater (Bluewater lies about 12 miles northwest of the city of Grants), or about 20 miles northwest of Mount Taylor. Section 25 lies about 6 miles east-southeast of Haystack Mesa, about 9 miles northeast of the village of Bluewater, or about 15 miles northwest of Mount Taylor.

The field examinations had the dual purpose of investigating by geologic and ground magnetometer traverses the unusual occurrence of the observed negative magnetic anomalies in close association with observed radioactivity anomalies, and of investigating the possibility that other geophysical methods, in addition to the standard radioactive method already employed, might offer some additional help, either directly or indirectly, in the search for uranium ore in progress in the Grants district.

The writer wishes to thank Mr. Irving Rapaport of the Atomic Energy Commission and his staff for their cooperation and help given in several conferences during the field tests and examinations. The work upon which this report is based was done on behalf of the Atomic Energy Commission.

GENERAL GEOLOGIC RELATIONSHIPS

The Grants district lies along the northern flank of the Zuni Uplift which is a northwestward-trending dome of early Tertiary age covering approximately 2,000 square miles (Towle and Rapaport, 1952). Sedimentary rocks of Jurassic and Cretaceous age are exposed in or near the area in which the field examinations were made. In sec. 19, where the magnetometer tests were made, are the volcanic cone El Tintero (fig. 1) and an extensive lava bed that extends southward to the village of Bluewater. Mount Taylor lies about 20 miles southeast of El Tintero. Hunt (1938, p. 73) describes the area north of Bluewater, which includes the El Tintero cone area, as follows:

> Very recent flows of basalt are found in the valley of the Rio San Jose along the south border of the (Mount Taylor) volcanic field. These flows were given only casual attention, because none were supplied by vents within the (Mount Taylor) field. Some of the vents are along the east side of the Zuni Mountains, others are north of the village of Bluewater, and others are near Laguna Pueblo. The flows have exceedingly fresh surfaces, which, combined with their position in the valley bottom, make them appear as if they had been flowing only yesterday. These flows are more ferromagnesian than most of the sheet eruptives of the Mount Taylor volcanic field. They consist of labradorite with a high percentage of olivine, slightly less augite, and some magnetite.

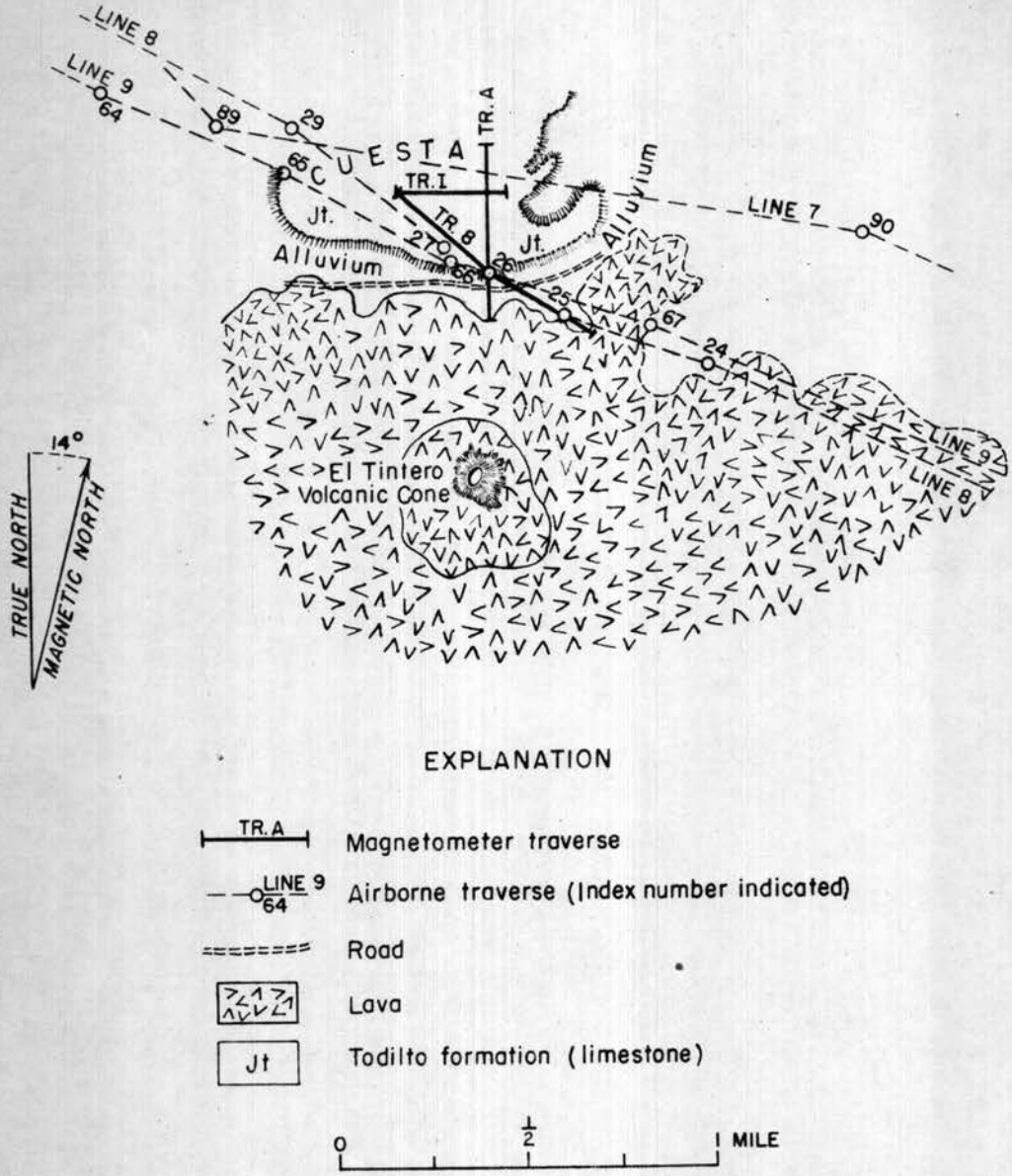

Figure I. - Map of surveyed area, near Grants, New Mexico - 1952.

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In the test area in sec. 19 the prominent geologic features are: (1) the red southward-facing cliff of Entrada sandstone capped with Todilto limestone, which forms a bench or cuesta extending to the north away from the cliff and (2) El Tintero volcanic cone (figs. 1 and 2). Exposures of the lava bed extend northward from El Tintero to within about 500 feet of the south face of the cliff (fig. 1). A mantle of alluvium, probably between 2 and 5 feet in average thickness, covers the Todilto limestone. Except at or near the edge of the cliff, the alluvium is probably sufficiently thick to mask completely the radioactivity of the ore within the Todilto limestone. At least locally in this area the alluvium or residual soil apparently contains some radioactive minerals.

Uranium deposits

The tests and field examinations discussed in this report were confined solely to the ore deposits in the Todilto limestone, which is the principal ore horizon in the Grants district.

Uranium deposits of the Grants district are described by Towle and Rapaport (1952) as follows:

> .....Irregular, blanket-type uranium deposits are in terrestrial Jurassic sediments. The principal ore-horizon is the upper recrystallized portion of the Todilto limestone. This limestone erodes as benches one-half to three miles wide, enabling relatively cheap exploration and open-pit mining. Ore deposits have also been discovered in the sand lenses of the Morrison formation, 500 to 800 feet stratigraphically above the Todilto. The Morrison erodes into steep cliffs, necessitating more expensive exploration and mining methods.

> The uranium minerals in the Todilto are carnotite, tyuyamunite, and uranophane; finely disseminated pitchblende is found where the deposits are removed from the effects of superficial oxidation. Gangue minerals are pyrite, hematite, calcite, and traces of barite and fluorite. The sandstone ores in the Morrison contain carnotite and schroeckingerite, associated with limonite and organic material. The ore deposits are believed to have achieved their present form by the lateral percolation of slightly heated Tertiary waters. Uranium, however, may have originally been contributed during the Jurassic.

According to J. W. Gruner (personal communication from I. Rapaport), hematite existing as a pseudomorphic replacement of pyrite is associated with the uranium minerals in sec. 19. Because of this replacement the ore is now impoverished of pyrite and relatively enriched with hematite.

In sec. 25, however, a normal amount of pyrite is found in the uranium ore, as replacement of the pyrite by hematite has not occurred to any considerable extent (personal communication from I. Rapaport). The "normal" amount of pyrite is probably considerably less than 1 percent in terms of percentage of the rock volume.

To the geophysicist, the problem of whether the uranium deposits may be genetically related to dikes, known to exist in the Grants district, is of paramount importance principally because the discovery of the dikes is possibly amenable to geophysical methods.

According to Rapaport (personal communication), however, no genetic relationship between the dikes and the ore bodies is known. He stated further that in the Laguna area, east of Grants, good exposures of dikes which cut the uranium bodies were found, thus indicating that some of the dikes are older than the uranium bodies.

INSTRUMENT AND FIELD TECHNIQUES

A standard, temperature-compensated Askania vertical magnetometer with a sensitivity of 29 gammas per scale division was used for the ground surveys. Three traverses were made: one insofar as possible directly below airborne line 8 (Traverse 8); one trending north from the north edge of the lava, up and over the south face of the cliff, and approximately 1,600 feet along the Todilto limestone bench (Traverse A); and a third over a uranium body (Traverse I). About 140 magnetometer stations were occupied in a total traverse distance of about 7,500 feet. The magnetometer observations were made generally at 20- or 25-foot intervals over exposed lava beds or in areas of steep magnetic gradients, at 25- or 50-foot intervals over mineralized areas, and at 100- to 200-foot intervals over unmineralized areas or areas of gentle magnetic gradients. Distances along traverses were measured with a cloth tape.

The ground magnetometer traverses within the area of the Atchison, Topeka and Santa Fe Railway grid system were tied to this grid. The traverses beyond the area of this grid system were tied to conspicuous features on the ground, such as roads, cliffs, El Tintero volcanic cone, and isolated trees, which were plainly visible on the aerial photograph (approximate scale of the aerial photograph: 1.85 inch equals 1 mile).

MAGNETIC OBSERVATIONS

Ground magnetometer traverse 8 is characterized by a gradual decrease in vertical magnetic intensity southeastward across the bench or cuesta toward the cliff, a minimum of about 1,400 gammas near 200E (about 250 feet south of the edge of the cliff) accompanied by a small maximum near 375E, and a highly irregular intensity pattern for the remainder of the traverse (fig. 3).

The irregular magnetic intensity pattern southeast of 375E is probably caused by lava lying immediately beneath the thin mantle of alluvium. Lava is exposed in some places along traverse 8 southeast of the road, and probably extends northwestward beneath the alluvium at least as far as 375E.

The negative anomaly at 200E may be caused by a dike, with inverse remanent magnetization, or, equally plausibly, the negative anomaly may be the magnetic manifestation of the northwest edge of the lava bed. Small pieces of lava float were tested and found to reveal strong remanent magnetization, but no oriented specimens from outcrops were taken.

The aeromagnetic anomaly can be correlated reasonably well with the ground magnetic anomaly. The minimum of the aeromagnetic anomaly (fig. 3), which is about 600 gammas in magnitude, lies about 230 feet northwest of the minimum of the ground magnetic anomaly. The offset is probably caused largely by either errors of location

or instrumental lag, or a combination of these factors; the amount of offset lies within the margin of location error for airborne surveys. As the airborne measurements are of total intensity measured from an arbitrary datum, there can be no direct comparison with the magnitude of ground measurements of vertical intensity.

The airborne radioactivity maximum (fig. 3), located at about 1030W, lies over or close to areas where uranium minerals are known to occur at shallow depths in the limestone forming the top of the cuesta. The radioactivity peak lies about 1,000 feet northwest of the aeromagnetic minimum and about 1,230 feet northwest of the ground magnetic minimum.

The general pattern of the magnetic profile of traverse A (fig. 4) is somewhat similar to that of traverse 8. Southward over the Todilto bench, the vertical magnetic intensity decreases and reaches a minimum of about 1,800 gammas at 150N, about 250 feet south of the edge of the cliff, then increases in magnitude to station 75N, where an irregular intensity pattern begins and persists to the south over the lava bed. The irregular intensity values indicate that the lava extends north at least as far as about 75N. As before, the negative center is due either to an inversely magnetized dike or is the magnetic manifestation of the north edge of the lava bed.

The trend of the magnetic negative anomaly, as sketched on figure 2 on the basis of traverses 8 and A only, is approximately

east-northeast or parallel to the face of the cliff. The data are insufficient to interpret confidently the significance of the magnetic trend.

Ground magnetometer traverse I (fig. 5) was taken over a uranium body. There are slightly anomalous magnetic intensities in places on this traverse, but any interpretation of them is inconclusive because of the broken drill rods that were left in at least one of the many drill holes along the traverse.

CONCLUSIONS

The results of the ground magnetometer tests indicate that the apparent correlation between the negative aeromagnetic anomaly and the positive airborne radioactivity anomaly is probably fortuitous and cannot be attributed to a genetic relationship between uranium mineralization and the intrusion of dikes or the extrusion of the basaltic lava flow.

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Towle, C. C., and Rapaport, I., 1952, Uranium deposits of the Grants district, New Mexico, A.I.M.E. Mining, Geology and Geophysics Division, Abstract of Technical Papers, 1952 Annual Meeting, abstract only, p. 19.

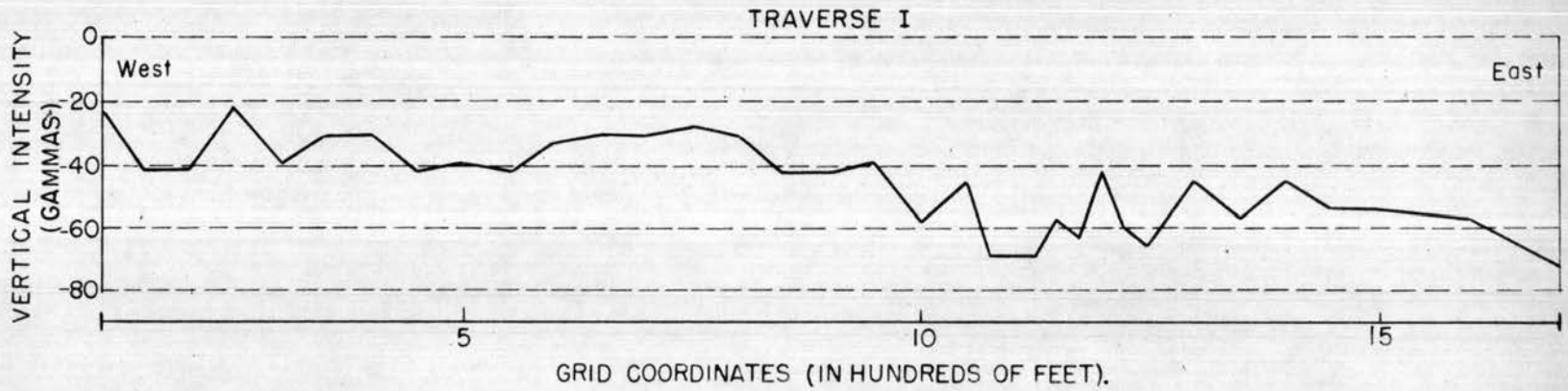

Figure 5. - Magnetic profile along Traverse I.

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RECOMMENDATIONS

The existence of hematite in the ore and especially the shallow depth of the ore may justify some ground magnetometer surveys of an exploratory nature in the future. Magnetometer tests should be made first in a drilled-out area where lost tools have been carefully recorded, to ascertain whether recognizable magnetic anomalies exist over or adjacent to the uranium ore. Such magnetometer tests should be made first in sec. 19, where more hematite exists, and next in sec. 25. Unless recognizable magnetic anomalies over or adjacent to the ore are firmly established, no extensive ground magnetometer exploration will be justified. The experimental work discussed is not included in current Survey plans, but it will be considered if the Commission so requests.

Towle and Rapaport have suggested that the ore deposits have achieved their present form by the lateral percolation of slightly heated Tertiary waters. If this is true the location of concealed Tertiary intrusives might help to indicate the probable sources of the heat and the direction of migration of the waters. Airborne magnetic surveys would aid greatly in locating such intrusives; and, if the Commission wishes, the Survey will consider undertaking such surveys.

To date all large airborne radioactive anomalies found over the Todilto limestone can be corelated with the occurrence of uranium

minerals in the ground. Airborne radioactive anomalies found occasionally over the lava beds are apparently not as diagnostic, however, as they may be the cumulative effect of widespread traces of radioactive material. In many places the mantle of alluvium masks the radioactive effect of uranium-bearing bedrock, and uranium ore bodies, without accompanying airborne radioactive anomalies, have been found (personal communication from I. Rapaport).

Continuation of the airborne radiometric survey of the outcrop of the Todilto, completed thus far only in the Grants district, is recommended on a regional scale to outline promising areas that might contain additional deposits. Such a survey would cost about $15,000, and if approved by the Commission, might be undertaken by the Survey in the 1953 field season.

Brief experimental self-potential traverses probably should be made to determine whether or not this method can be applied to the Grants-type deposits in future exploration. The electrical tests should be made preferably in the early spring when the moist ground will afford better contact for the nonpolarizing electrodes. The probable great depth to the ground water table, the small percentage of pyrite, and other factors diminish the likelihood that substantial, consistent, self-potential anomalies will be found associated with the ores. The shallow depth of the ore and the presence of pyrite, however, seem to justify at least some brief experimental electrical tests. None are planned now but they will be considered if the Commission desires.

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Airborne Radioactivity Survey in the Vicinity of Grants, McKinley and Valencia Counties, New Mexico

TEI-161

Trace Elements Memorandum Report 161

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UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

AIRBORNE RADIOACTIVITY SURVEY IN THE VICINITY OF GRANTS, McKINLEY AND VALENCIA COUNTIES, NEW MEXICO

by

Frank W. Stead

July 1951

Trace Elements Memorandum Report 161

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ILLUSTRATIONS
(In envelope)

Figure 1. Airborne radioactivity survey in Grants, McKinley and Valencia Counties, New Mexico

2. E-A records near Haystack area

A. Geiger-Mueller counters, T-C channel

B. Geiger-Mueller counters, automatic sensitivity

C. Radar altimeter

D. Magnetic airborne detector

3. Magnetic profile, flight line 7 E

4. Magnetic profile, flight line 8 W

5. Magnetic profile, flight line 9 E

AIRBORNE RADIOACTIVITY SURVEY IN THE VICINITY OF GRANTS, McKINLEY AND VALENCIA COUNTIES, NEW MEXICO

by

Frank W. Stead

ABSTRACT

An airborne radioactivity survey in the vicinity of Grants, New Mexico, was made on May 28, 1951; aeromagnetic measurements were made concurrently with the radioactivity measurements. Several radioactivity anomalies were noted in conjunction with negative magnetic anomalies; this association is unusual and may reflect a genetic relationship between the uranium mineralization and the geologic structure causing the negative magnetic effect. Further investigation of the vicinity of the anomalies near the Haystack area, including a ground magnetometer survey, seems warranted.

INTRODUCTION

The airborne radioactivity survey in the vicinity of Grants, New Mexico, was made on May 28, 1951, as a part of a cooperative program with the U. S. Atomic Energy Commission. The accompanying map, figure 1, shows the location of the radioactivity and aeromagnetic anomalies over an area of about 45 square miles.

The survey was made by Geiger-counter and scintillation-counter equipment mounted in a Douglas DC-3A aircraft. Aeromagnetic measurements were made concurrently with the radioactivity measurements. All traverses were flown at a nominal 500-foot flight level at quarter-mile intervals. Aerial photographs were used for pilot guidance, and the flight path of the aircraft was recorded by a gyrostabilized continuous strip-film camera. The distance of the aircraft from the ground was measured with a continuously recording radar altimeter. A total of $2\frac{1}{2}$ hours were spent in actual surveying. Approximately 300 miles of traverse were flown.

The flight lines in the area, shown on figure 1, were oriented to give the maximum coverage of the outcrop of the Todilto limestone of Jurassic age with the objectives of determining the response of the radiation detection equipment over known radioactive mineralization and of locating other radioactive deposits in the general vicinity. One flight line, the extension of line 7 westward along the outcrop of Todilto limestone to near Gallup, New Mexico, has not been plotted on a base map as no anomalies were found along that flight line.

RADIOACTIVITY MEASUREMENTS

All radioactivity measurements were made approximately 500 feet above the ground by: (1) a dual channel radiation detector employing

19 2 by 42-inch Geiger counters; and (2) a scintillation detector employing 4-inch diameter by 2-inch thick sodium iodide crystals.

The dual-channel radiation detector has two output channels, the C channel and the T-C channel. The C channel records the multiple or coincidence pulses originating from hard cosmic radiation striking the bundle of counters; the T-C channel records the anti-coincidence pulses or the total counting rate minus the coincidence counting rate. A portion of the record for the T-C channel is shown in figure 2 A where the average counting rate is roughly 300 counts per second at 40 divisions on the E-A tape. The time constant of the T-C channel of the dual-channel radiation detector, with a standard counting-rate meter output, is one second.

The scintillation detector consists of the 4-inch sodium iodide crystals as the radiation detector proper, a pre-amplifier, a linear amplifier and discriminator, and a modified counting-rate meter. The only unusual feature is the modified counting-rate meter which records automatically alternate one-second measurements from two identical output stages; thus, each channel accumulates pulses for one second and records that measurement in the following second to complete the cycle. Thus, the output of the modified counting-rate meter is comparable to that of a scaler for a one-second period of measurement, an improvement over the slower and more complex response of a standard counting-rate meter with a one-second time constant.

The automatic correction of the radiation measurements for variation in distance of the aircraft from the ground, achieved by utilizing the radar altimeter output to modify the counting-rate meter output, was applied only to the modified counting-rate meter of the scintillation detection equipment; it was not applied to the dual-channel radiation detector. Using this correction, an anomaly will maintain the same apparent amplitude when measured between 250 and 1,000 feet above the source, although the statistical fluctuation of the measurements becomes larger with increase in distance from the source.

During the survey, the Geiger counters were connected through a pre-amplifier to: (1) the dual-channel radiation detector (T-C channel); and (2) one of the modified counting-rate meters of the scintillation detection equipment whose output was also corrected for distance from source. Comparison of figures 2 A and 2 B shows the gain in resolution of the modified counting-rate meter with a one-second period of measurement, where the standard deviation would be $\sqrt{N}$, over the typical counting-rate meter of the dual-channel radiation detector with a one-second time constant, where the standard deviation would be $\sqrt{2NXTC}$.

A Halross Model 939 Scintillometer was carried during the survey and by visual comparison with the records of the other equipment was found to be relatively sluggish and insensitive.

Measurements of total magnetic intensity were made simultaneously with the radioactivity measurements, using a Model ASQ-3A airborne magnetometer.

Extent of coverage

At a nominal 500-foot flight level, the width of the zone from which the radioactivity is measured is at least 1,400 feet. Thus, at quarter-mile spacing of flight lines or 1,320-foot intervals, the entire area should be covered adequately. During this particular survey, deviations from planned parallel flight lines were made on lines 6, 7, 8, and 9 to avoid topographic highs where the Todilto outcrop was lacking. It is possible that small areas of considerable activity midway between flight lines 6 and 7 may not have been noted.

Location of anomalies

The approximate location of each radioactivity and magnetic anomaly is shown on figure 1 by appropriate symbols. The compilation and plotting of data _/ require the assumption of straight-line flight

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_/ Jensen, Homer, and Balsley, J. R., Jr., Controlling plane position in aerial magnetic surveying: Eng. & Min. Jour., vol. 147, no. 8, pp. 94-95, 153-154, August 1946.

---

and constant ground speed between recognizable positions plotted on the

maps; thus, if the distance between such points is large, the error in estimated position midway between the points may be considerable. In this survey, the location of anomalies, as shown on figure 1, is correct within 300 feet; more precise plotting is not possible due to inaccuracies in the base map of that order of magnitude.

RADIOACTIVITY AND MAGNETIC ANOMALIES

The radioactivity and magnetic anomalies recorded during the survey are listed in table 1 and are shown on figure 1 by appropriate symbols. Small changes in radiation intensity occurring over a flight distance of more than 1 mile (24 seconds average flying time) probably reflect a characteristic of the soil mantle or formations exposed at the surface and have not been shown as anomalies.

The pertinent E-A records for the anomalies of greatest interest near the Haystack area in Sec. 19, T. 13 N., R. 10 W., are shown in figures 2 A, 2 B, 2 C, and 2 D. The records for the scintillation detector during this particular survey were essentially valueless due to excessive noise in the amplifier and were used solely as a confirmation of anomalies recorded by the dual-channel radiation detector.

Figure 2 A is the E-A record of the Geiger counters from the T-C channel of the dual-channel radiation detector and is uncorrected for variation in distance from ground. The counting rate at 40 divisions is approximately 300 counts per second with a one-second time constant;

Table 1

Radioactivity and Aeromagnetic Anomalies

Flight line	Location of radioactivity anomaly 1/	Location of aeromagnetic anomaly 1/
4	No. 1254.8S 2/	
5	No. 1301.5S No. 1303.6S	
7	No. 1380.7S No. 1389.4M	 No. 1389.7
8	No. 1426.5L No. 1430.2M No. 1439S	No. 1426.0 3/
9	No. 1456S No. 1466.3L	 No. 1466.2 3/

1/ Location designated by serial number on strip photograph and by corresponding edge marks on other records; on figure 1 the first two numbers have been dropped to avoid 5 digit numbers.

2/ S, M, L after number denote respectively small, medium and large radioactivity anomalies.

3/ Magnetic anomalies on lines 8 and 9 occur so close together due to overlapping of flight paths that they are plotted as one anomaly on figure 1.

thus, the standard deviation of measurement is slightly less than 3 divisions on the E-A tape. The large anomaly at 1426.5 is roughly 8 times the standard deviation of the general background counting rate; the medium anomaly at 1430 is roughly 3 times the standard deviation.

Figure 2 B is the E-A record of the Geiger counters connected to the modified counting-rate meter including automatic correction for distance from the outcrop. The counting rate at 10 divisions on the E-A tape is roughly 300 counts per second, the same as for the dual-channel radiation detector, but the measurement reflects a one-second period in which the pulses are accumulated as in a standard scaler rather than a one-second time constant. The standard deviation for each one-second period is the square root of the total events in that second. Comparison of figures 2 A and 2 B shows the advantage of sharpening the resolution of measurement; the anomalies in 2 B are considerably easier to interpret than those in 2 A.

Figure 2 C is the radar altimeter record. The distance from the ground for the large anomaly at No. 1426.5 was 400 feet and for the anomaly at No. 1430 was also 400 feet.

Figure 2 D is the E-A tape for the magnetic airborne detector where the full-scale deflection was 200 gammas; thus, several scale shifts were made to obtain a complete record of the negative anomaly whose minimum was at No. 1426. It will be noted that the large

radioactivity anomaly at No. 1426.5 is almost coincident with the sharp negative magnetic anomaly, in excess of 500 gammas, at No. 1426.

The significant portions of magnetic measurements have been rectified and are shown as magnetic profiles for flight lines 7, 8, and 9 in figures 3, 4, and 5 respectively. Rectification of measurement here includes changing to rectilinear coordinates and adjusting the horizontal scale to 1 inch to the mile and the vertical scale to 1 inch equals 160 gammas.

Interpretation of anomalies

The interpretation of the radioactivity anomalies is relatively straightforward as nearly all the anomalies can be directly related to ground areas where present exploration is underway. Exceptions are anomalies No. 1380.7 on line 7, No. 1439 on line 8, and No. 1456 on line 9 that, from examination of the strip photograph, do not appear to be related to any present exploration. However, these anomalies are all small and may represent no more than small local areas in which the general level of radioactivity is several times normal, a not unusual variation in background.

In the vicinity of the Haystack area, Sec. 19, T. 13 N., R. 10 W., the almost coincident occurrence of medium and large radioactivity anomalies with sharp negative magnetic anomalies is highly unusual.

Although the relationship may be one of chance, the two cases separated by 0.7 miles suggest a possible genetic relationship rather than an accidental relationship. The negative magnetic anomaly may reflect a diabase dike or plug with inverse remanent magnetization; thus, the uranium mineralization in the Todilto limestone may be hydrothermal (?) and genetically related to a buried diabase dike or plug which was the source, or channelway, for the mineralizing solutions. The nearby presence of a volcanic cone one mile to the south of the Haystack area lends credence to this possibility.

The negative magnetic anomaly, No. 1426 on line 8 and shown on the magnetic profile in figure 4, is in excess of 500 gammas and should be several thousand gammas if measured on the ground.

CONCLUSIONS

The occurrence of negative magnetic anomalies in close association with radioactivity anomalies known to represent uranium mineralization of commercial importance is sufficiently unusual to warrant further investigation. A ground magnetometer survey, properly coordinated with all available geologic data, is recommended in the Haystack area. Should such an investigation demonstrate any genetic relationship between uranium mineralization and the geologic structure causing the negative magnetic anomalies, further consideration might be given to a more comprehensive radioactivity-aeromagnetic survey of the surrounding region.

U. S. Geological Survey Library
Denver Branch

8

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
WASHINGTON 25, D. C.

224 New Customhouse
Denver 2, Colorado

August 27, 1954.

Memorandum

To: Secretary to the Operating Committee, DMEA

From: Executive Officer, DMEA Field Team, Region IV

Subject: Docket No. DMEA-3152 (Uranium), Hanosh Mines, Inc., McKinley County, New Mexico.

Enclosed are four copies of the report of field examination on the subject application and two copies of Form 3b.

This docket has been closed by this office effective August 16, 1954 because the applicant has not provided an approved Assignment of Lease.

W. H. King

Enclosures

RDB:cwm

cc: Docket
Administrator, DMEA
WMTraver
Arnold Brokaw
AHKoschmann
Chron.

Reviewed by
DMEA OPERATING COMMITTEE
9-3-54
(date)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

Mining Division
Region IV

March 3, 1954.

Memorandum

To: Field Team, Region IV

From: Chief, Mining Division, Region IV

Subject: Report of Examination - DMEA Docket 3152 (Uranium), Hanosh Mines, Inc., McKinley County, New Mexico.

Enclosed are eleven copies of the engineering report of examination on the subject docket.

The applicant requested $26,460.69 to drill the property on a scale which appears to be too ambitious to the examining engineer.

The examining engineer recommends a drilling program to be divided into three stages, the work to consist of 342 holes averaging 40.5 feet in depth at an estimated total cost of $13,851.00.

We concur in this recommendation.

W. H. King

W. H. King

Enclosures

Reviewed by
DMEA OPERATING COMMITTEE
9-3-54
(date)

Memorandum

February 19, 1954

To : W. H. King, Chief, Mining Division, Region IV

From : Chief, Mining Methods Br., Mining Div., Region IV

Subject : Engineering Report on Docket DMEA-X152, Hanosh Mines, Inc., Uranium Property, McKinley County, N. Mex.

Enclosed are original and 9 copies of a revised report by Lloyd L. Farnham of the Bureau of Mines on the above property. The other copy will be forwarded to you by R. P. Fischer of the Geological Survey's Grand Junction office. J. D. Strobell of the Geological Survey has read and approved this report by Farnham.

The DMEA field examiners recommend that Hanosh Mines, Inc. be granted exploration assistance to drill its property north of Grants, N. Mex. I concur with this recommendation.

Walter R. Storms

Walter R. Storms

CC W. H. King (10)
R. P. Fischer
DMEA-X152
DF

WRStorms:frj

Reviewed by
DMEA OPERATING COMMITTEE
9-3-54
(date)

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Defense Minerals Exploration Administration
Denver Federal Center
Denver 2, Colorado

February 23, 1954

Memorandum

To: DMEA Field Team, Region IV

From: A. H. Koschmann

Subject: DMEA Docket 3152, Hanosh Mines, Inc., McKinley County, New Mexico

Enclosed are 11 copies of a geologic report by J. D. Strobell, Jr., of the U. S. Geological Survey covering the above docket.

The recommended plan of exploration has been revised to agree with that suggested by Lloyd Farnham of the Bureau of Mines office in Tucson, as requested by the Field Team in December.

A. H. Koschmann

A. H. Koschmann
Supervising Geologist
Colorado-Wyoming

Enclosures (11)

Reviewed by
DMEA OPERATING COMMITTEE
9-3-54
(date)

C
O
P
Y

UNITED STATES
DEPARTMENT OF THE INTERIOR
Geological Survey
P. O. Box 360
Grand Junction, Colo.

February 24, 1954.

Memorandum

To: W. H. King, DMEA Field Team, Region IV

From: R. P. Fischer, Colorado Plateau District

Subject: DMEA 3152, Hanosh Mines, Inc., Uranium Property, McKinley County, New Mexico.

Forwarded herewith is carbon copy of Farnham's report, DMEA 3152, Hanosh Mines, Inc., Uranium Property, McKinley County, New Mexico, as requested by Storms in his memorandum of February 17.

/s/ R. P. Fischer
District Supervisor

Enclosure

Reviewed by
DMEA OPERATING COMMITTEE
9-3-54
(date)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

P. O. Box 360
Grand Junction, Colo.

February 19, 1954

Memorandum

To: A. H. Koschmann, Field Team, Region IV

From: R. P. Fischer, Supervisor, Colorado Plateau District

RPF

Subject: DMEA 3152, Hanosh Mines, Inc., McKinley County, New Mexico

Transmitted herewith are 11 copies of Strobell's revised report on the above application. The recommended plan of exploration has been revised to agree with that suggested by Lloyd Farnham of the Bureau of Mines office in Tucson, as requested by the Field Team in December.

Enclosures 11
JDS/mlr

cc: A. H. Koschmann (1 extra)
W. H. King
W. R. Storms

Reviewed by
DMEA OPERATING COMMITTEE
9-3-54
(date)

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
P. O. BOX 360
GRAND JUNCTION, COLORADO

October 9, 1953

Memorandum

To: A. H. Koschmann, DMEA Field Team, Region IV

From: R. P. Fischer, Acting Supervisor
Colorado Plateau District

Subject: DMEA 3152, Hanosh Mines, Inc., McKinley County, New Mexico

Transmitted herewith are eleven copies of a geologic report on the ground leased by the Hanosh Mines, Inc., McKinley County, N. Mex. The company applied for assistance in exploring for uranium; they propose to do 30,410 feet of drilling and related work at an estimated cost of $26,460.69.

The attached report is prepared by J. D. Strobell, Jr., and is based on a joint field examination on September 15 with Lloyd Farnham, USBM, and Irving Rapaport, representing the applicants. The examining team also conferred with P. E. Melancon, AEC geologist, who is in general agreement with the conclusions and recommendations offered in the report.

Strobell concludes that exploration in the area has a good chance of finding 6,000 to 9,000 tons of ore, and thus is favorable for exploration. On this basis, he recommends an exploration contract, pointing out at the same time, however, that the value of the ore expected probably will not be sufficient to repay through royalty payments the entire cost to the government. A program of ~~15,000~~ feet of drilling, smaller than that proposed by the applicant, is suggested. 13,851

I concur with these conclusions and the suggested plan of exploration.

R. P. Fischer

R. P. Fischer
Acting District Supervisor

Reviewed by
DMEA OPERATING COMMITTEE
9-3-54
(date)

Enclosures 11

RPF/mlr

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

In August 1953, Hanosh Mines, Inc. applied to the Defense Minerals Exploration Administration, under the Defense Production Act of 1950, as amended, for an exploration loan amounting to $26,460.69. The application was docketed as DMEA-3152. The funds requested were to be used in the exploratory drilling of a uranium prospect situated in the Grants district of northwestern New Mexico. The property was examined[1/] on September 15, 1953.

Extensive exploration has been under way in the Grants region since 1950 when the presence of uranium first was detected. The deposits occur as sporadic, irregular, blanket-type replacements in the Todilto limestone and also in some of the overlying formations. The Todilto in the Grants area is a persistent gently dipping (4°) bed about 20 feet in thickness which owing to its relative resistance to erosion, usually caps many of the lower benches and mesas along the valley floors.

The project property covers an unexplored area of about 43 acres that is underlain by this ore-bearing limestone. Except in the immediate vicinity of the outcrop the favorable bed is usually completely covered with varying amounts of soil and younger sediments, which increase progressively in thickness down the dip of the limestone. This mantle of overburden not only covers the area proposed for exploration but prevails generally throughout the district. Structural controls or other ore-guides usually are lacking so that closely spaced

1/ Farnham, L. L., Mining Engineer, Bureau of Mines; Strobell, J. D., Geologist, Geological Survey

Reviewed by
DMEA OPERATING COMMITTEE
9-3-54
(date)

blind drilling has been, and still is the only practical means of discovering ore in the district. Exploratory drilling of this nature has found important, but sporadic ore bodies occupying an irregular belt that extends for about 3 miles to the southeast and for some 4 miles west of the subject property.

The applicant proposed to explore the 43-acre tract by 30,410 feet of rotary drilling in 706 holes, spaced from 100 to 25 feet apart. This work was estimated to cost $26,460.69. As this amount of drilling appeared excessive for the purpose of exploration, an alternative program was recommended which involved 13,850 feet of drilling in 342 holes at an estimated cost of $14,500.

The area proposed for exploration is favorably situated in respect to a productive trend and for that reason it appears to be worthy of exploration. Therefore, it is recommended that a loan amounting to not more than $14,500 be approved.

UNITED STATES DEPARTMENT OF THE INTERIOR
DOUGLAS McKAY, SECRETARY

DEFENSE MINERALS EXPLORATION ADMINISTRATION

REPORT OF EXAMINATION BY FIELD TEAM
REGION IV

DMEA 3152, Hanosh Mines, Inc.,

Section 22, T. 13 N., R. 10 W., Grants District,

McKinley County, New Mexico

Uranium

Geologic report

J. D. Strobell, Jr., Geologist
U. S. Geological Survey

October 9, 1953

Reviewed by
DMEA OPERATING COMMITTEE
9-3-54
(date)

HANOSH MINES, INC.,
McKINLEY COUNTY, NEW MEXICO

INTRODUCTION AND SUMMARY

Application has been made by Hanosh Mines, Inc., for government assistance (DMEA 3152) in exploring for uranium in the Todilto limestone of the Grants District, McKinley County, N. Mex. The applicant proposes 30,410 feet of drilling, at an estimated cost of $26,460.69, to explore about 45 acres in the NE ¼, sec. 22, T. 13 N., R. 10 W. The property was examined on September 15, by Lloyd Farnham of the U. S. Bureau of Mines, Tucson, Ariz., and J. D. Strobell, Jr., of the U. S. Geological Survey, Grand Junction, Colo. The examiners were accompanied by the applicant's representative, Mr. Irving Rapaport, and conferred also with Mr. P. E. Melancon, District Geologist of the U. S. Atomic Energy Commission, Grants, N. Mex.

The property lies on allotted Indian lands. Prospecting and mining rights are leased to the applicant with the approval and under the general supervision of the Bureau of Indian Affairs, U. S. Department of the Interior. Royalties stipulated by that Bureau range from 10 to 20 percent of the mine value of the ore (excluding allowances for development and transportation) and include in addition 10 percent of any bonuses paid by the U. S. Atomic Energy Commission.

A somewhat curtailed program (about 50 percent reduction) to explore this property with government assistance is recommended. The applicant's proposal is considered to carry the exploration too far into the development phase not appropriately a part of DMEA exploration. A maximum of ~~15,000~~ 13,851 feet of drilling in primary and offset holes is recommended. It is also suggested that in addition to the radiometric logging of these holes proposed by the applicant, collection of cuttings from the limestone be required until such time as the reliability of radiometric logging is definitely established in the district.

GEOLOGY

In the Grants district, uranium deposits occur in the Todilto limestone and Morrison sandstone beds of Jurassic age, and in the overlying Cretaceous rocks. The Hanosh lease in sec. 22 covers an area underlain by the Todilto limestone. The Todilto caps cliffs of the underlying Entrada sandstone and forms a broad bench where the overlying Summerville formation has been removed by erosion. It dips very gently northeastward across the property and is covered by a veneer of dune sand and alluvium up to about 50 feet thick, which may also locally conceal remnants of the Summerville formation. Except along the rim at the top of the Entrada cliff, the limestone is completely covered on the Hanosh property. Near the northern edge of the property increasing amounts of the silty sandstone of the Summerville formation are likely to be present. The limestone is about 20 feet thick on the average, and the applicant states that the overburden on the property averages only 18 feet in thickness.

ORE DEPOSITS

In the Grants district, uraniferous minerals locally coat bedding planes and joint surfaces of the limestone, are disseminated in blebs and crystals, and are associated with coarsely crystalline carbonates in veinlets. Among the important ore minerals are tyuyamunite, carnotite, uranophane, and uraninite. These minerals are locally present in sufficient amounts to form ore bodies of irregular plan and thickness without sharply defined limits. Controls of their localization are not well understood. The ore bodies occur at all positions between the top and bottom of the limestone. There is evidence of their localization along the axial portion of minor folds, but not all such folds are mineralized. This produces elongated ore bodies, as does localization on dominant joints. The ore bodies range in size from small tabular masses covering a few square feet to large bodies several hundred feet across. The thickness ranges from 1 foot or less up to about 14 feet. Most of the ore bodies are small elongated masses containing less than 2 or 3 thousand tons. The average grade of the ore shipped ranges from .20 to about .25 percent U_3O_8, and rarely up to .35 percent U_3O_8.

The applicant has developed no ore on this property. There are two showings of uranium mineralization on the rim exposures, and one near the northwest corner of the section that is in a limestone lens near the base of the Summerville formation. The nearest known ore is that discovered in the southern part of sec.23 by the Santa Fe Railroad and in the northern part of sec. 26 by the applicant. Several ore bodies have been found farther southeast in secs. 25, 30, and 31.

In these several sections, the known ore bodies are estimated to contain from 25 to more than 10,000 tons of ore apiece. The average ore body contains on the order of 3,000 tons. The size and distribution of these known deposits might be considered representative of the deposits expected in the area to be explored. The known ore bodies total about 40 in number, and were found by exploration of a combined area about 1.25 square miles in extent. It therefore seems possible that exploration of the applicant's 45 acres (.07 square mile) might discover 2 or 3 deposits that might contain as much as 6,000 to 9,000 tons of ore.

The value of this ore (before initial production bonus and haulage allowance), assuming an average grade between .20 and .25 percent U_3O_8, would range from $16.00 to $20.75 per ton. The value of the anticipated discoveries would therefore expectably be between $96,000 and $186,750.

The known ore bodies range in size from less than 25 feet in diameter up to 100x800 feet. Their small size and irregular shape make them difficult targets for exploration, but where they lie at shallow depths many small ore bodies can and will be mined at a profit. Closely spaced drilling therefore seems justifiable in shallow ground such as the area under consideration.

PROPOSED EXPLORATION

The exploration proposed by the applicant consists of a maximum of 30,410 feet of rotary drilling estimated to cost $26,460.69. It is proposed to do the drilling in three stages: (1) An initial grid of 207 holes (8,919 feet) spaced 100 feet apart to test the whole area; (2) a secondary grid of 286 holes (12,306 feet) consisting of 8 off-set holes spaced 50 feet apart around one initial hole in five; and (3) a tertiary grid of 213 holes (9,186 feet) consisting of 8 off-set holes spaced 25 feet apart around one secondary hole in ten. Radiometric logging would be used to determine which of the initial and secondary holes should be offset. Samples would be collected only from the holes drilled on 25-foot centers, and these samples would be tested radiometrically to determine the grade of the rock cut in drilling. Chemical assays would be made of a few of the samples to check the radiometric determinations.

The field examiners believe the area is favorable for finding uranium deposits, but that the applicant proposed more drilling than is needed for exploration. The following modified program is suggested:

Stage 1: The entire area should be tested with an initial pattern of holes spaced 200 feet apart, beginning 100 feet south of the north boundary line and 100 feet west of the east boundary line. This stage will require 48 holes, averaging 40.5 feet deep for a total of 1944 feet. Although this initial test would find only unusually large deposits, it will test for the presence of the ore-bearing limestone and may by chance find some small deposits. It does not in itself constitute an adequate test of the property because of the small size and narrow elongate shape of the typical deposits.

Stage 2: The second phase of the exploration should, therefore, provide sufficient footage to complete a 100-foot grid pattern, no holes to be drilled within 100 feet of the north and east property lines. Experience has shown that holes drilled on this pattern will indicate the presence of most deposits of average size, and would be accepted as a fair test of the property in the event of completely negative results. This stage will require 123 holes. Assuming they also average 40.5 feet in depth, they would total 4981.5 feet of drilling.

Stage 3: According to P. E. Melancon, AEC geologist, experience in the district indicates that one hole in six drilled on 100-foot centers will cut rock having enough radioactivity to justify off-setting. On this basis 28.5 of the holes drilled in Stages 1 and 2 might require additional holes to test the adjacent ground. Allowing 6 offset holes for each of these 28.5 holes, 171 holes should be provided for in Stage 3. These holes should be spaced 50 feet apart, and may be drilled 50 feet from the property lines. The suggested allowable maximum footage for Stage 3 is 6925.5.

It is further suggested that Stage 1 and Stage 2 holes be completed and their relative favorability be determined before the Stage 3 offset holes are drilled. In this way, the whole area can be appraised and the most favorable parts can be selected for further testing by offset drilling.

This program, totalling 13,851 feet of drilling, presents allowable maximum footages. By beginning with 200-foot spacing in Stage 1, it is possible that some parts of the area can be eliminated from further consideration, thus saving a few holes in stage 2. It is also possible that all of the allowable footage in Stage 3 might not be needed to test whatever favorable indications are obtained in Stages 1 and 2. On the other hand, in the event of many favorable showings, it is desirable to allow the use of unexpended Stage 2 footage in Stage 3. In this way, within the allowable maximum under the contract, some flexibility is obtained even though the program is organized in stages.

No drilling on 25-foot centers, as proposed by the applicant, is suggested, as it is believed that drilling on 100-foot centers with some 50-foot offsets will find most average sized deposits or at least suggest their proximity. Closer spaced drilling, however, probably would be required to obtain a reasonably accurate appraisal of the tonnage and grade of deposits and certainly would be required to develop them for mining. It is believed that the applicant should be willing to do at his own expense the work he considers necessary to develop ore for mining if the greater risks of exploration have already been taken in the DMEA project.

The applicant has proposed to take no samples from the holes drilled on 100- and 50-foot centers, but rather to rely upon radiometric determinations by in-hole logging equipment to select the holes to be offset. Although the AEC field personnel have recommended this practice, and it has been accepted by the DMEA examining team for use on projects already studied, a more critical analysis of the logging method shows that it has not been thoroughly tested and proved. Furthermore, the AEC does not have the capacity to do the radiometric logging on this project whereas they have promised to do it on other DMEA projects, and the applicant proposes instead to use unproved logging equipment. The examining team therefore recommends that, in addition to the proposed radiometric hole logging, samples of the drill cuttings representing 2-foot intervals throughout the Todilto limestone be taken from all drill holes. This sampling will of course increase the cost of the project, but it seems necessary for the present in order to ensure obtaining adequate guidance for the drilling and to establish the reliability of the logging equipment.

Experience in the Grants district has shown that the uranium ore in the limestone is essentially in radioactive equilibrium and that radiometric determinations with laboratory scalers or even with simple portable counters can be used, if the instruments are properly calibrated and checked, to determine the grade of samples. The applicant proposes to use radiometric determinations for assaying samples; 20 chemical assays of samples selected at random are also proposed as checks. The proposed plan of radiometric assaying with 20 chemical assays for checking is considered sound and should be acceptable to DMEA. All drill holes, however, should be sampled as suggested above.

CONCLUSIONS AND RECOMMENDATIONS

Exploration of the Hanosh property in sec. 22, T. 13 N., R. 10 W., McKinley County, N. Mex., by rotary drilling appears to have a favorable chance of finding as much as 6,000 to 9,000 tons of ore containing 0.20 to 0.25 percent U_3O_8. At the present price schedule, this ore will have a value of $96,000 to $186,750, which is probably not sufficient to repay completely the government's share of the cost of exploration. On the basis that the ground offers the chance of finding a significant amount of ore, however, it is recommended that the government enter into a contract for a maximum of ~~15,000~~ 13,851 feet of drilling to cover a primary ~~100~~ 200-foot grid, a secondary 100-foot grid, and about ~~140~~ 171 off-set holes at 50-foot spacing. It is desirable to use in-hole radiometric logging as proposed by the applicant, but cuttings should be collected through the limestone in all holes and selected samples checked by radiometric assay in order to establish the reliability of the technique. A few chemical assays should be provided to check the grade of possible discoveries.

DMEA-3152, HANOSH MINES, INC., URANIUM PROPERTY
McKINLEY COUNTY, NEW MEXICO

Engineering Report

By L. L. Farnham, Mining Engineer
U. S. Bureau of Mines

February 1954

Reviewed by
DMEA OPERATING COMMITTEE
9-3-54
(date)

DMEA-3152, MANOSH MINES, INC., URANIUM PROPERTY
McKINLEY COUNTY, NEW MEXICO

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INTRODUCTION

Late in August 1953, Hanosh Mines, Inc., applied to the Defense Minerals Exploration Administration under the Defense Production Act of 1950, as amended, for an exploration loan amounting to $26,460.69. The application was docketed as DMEA-3152. The funds requested were to be used in search of uranium deposits by means of 30,410 feet of rotary drilling.

The property was visited by the DMEA examiners[1/] on September 15, 1953. The initial engineering report, submitted in October 1953, has been revised in this report in accordance with recent policy decisions.

ACKNOWLEDGMENTS

Acknowledgments are made to Paul E. Melancon, formerly of the Atomic Energy Commission, and to Irving Rapaport for their assistance during the examination.

LOCATION AND PHYSICAL FEATURES

The property is situated about 19 miles north of the town of Grants in the NE¼ of Sec. 22, T. 13 N., R. 10 W., McKinley County, N. Mex. It can be reached by traveling west of Grants on U. S. Highway 66 for 3.2 miles, thence northward on State Highway 53 for 10.8 miles to a side road branching westward. The site of the proposed project is reached by proceeding about 4 miles in a northwesterly direction on this branch road (figure 1). The subject property is 22 miles from the uranium processing plant of the Anaconda Copper Mining Co. near Bluewater.

1/ Strobell, J. D., Geologist, Geological Survey;
Farnham, L. L., Mining Engineer, Bureau of Mines.

The area proposed for exploration is situated on a relatively flat, gently-sloping alluvium-covered bench or mesa. Altitudes above sea level range from a high of 7,120 feet at the southeast corner of the tract to a low of 7,050 feet at the northeast corner.

HISTORY AND PRODUCTION

The first mining activity in the Grants district began in 1950, following the initial discovery of uranium near Haystack Butte (figure 2). These deposits, situated about 4 miles west of the subject property, have proven to be the largest found to date in the district. Large scale production from this area is awaiting the completion of the Anaconda plant near Bluewater. The applicant's property, valuable only for grazing prior to the discovery of uranium in the region, has not been explored. Drilling on contiguous tracts, southeast of that held by the applicant, has disclosed important deposits. Four properties in this area were in production at the time of the examination.

OWNERSHIP AND EXTENT

The applicant reportedly holds a lease on the NE¼ of Sec. 22, T. 13 N., R. 10 W., McKinley County, N. Mex. This property is an Indian allotment and as such is under the jurisdiction of the Bureau of Indian Affairs of the Department of the Interior. A copy of the applicant's lease is not available. It is the writer's understanding that the royalty payments stipulated in the lease are based on a sliding scale starting at 10 percent for ore with a mill value of $20 a ton and increasing one percent for each $10 in added value. Under the lease, royalty is payable on all bonuses, premiums and other allowances received by the shipper.

The area proposed for exploration covers about 43 acres situated in the extreme northeast corner of Sec. 22. The land in Secs. 15 and 23, which immediately adjoins the subject property on the north and east, is either owned or controlled by the Atchison, Topeka & Santa Fe Railway Co. (figure 3). The applicant company is producing ore from another lease covering a portion of Sec. 26, T. 13 N., R. 10 W.

DESCRIPTION OF THE DEPOSITS

Uranium mineralization in the area under consideration occurs in the Todilto limestone. This formation is a persistent gently-dipping bed averaging about 20 feet in thickness. The tract proposed for exploration is underlain by this limestone. Its irregular outcrop marks the western and southern boundaries of the project area (fig. 3). Erosion has completely removed the Todilto limestone from all of Sec. 22 with the exception of the extreme northeastern corner which constitutes the area proposed for exploration. Except in the immediate vicinity of the outcrop the favorable bed is usually completely concealed by varying thicknesses of overburden. This is not only true of the tract under consideration but prevails generally throughout the district. Although shearings of uranium mineralization are not uncommon along the outcrop of the Todilto it appears that very few of the district's more important ore bodies have been found exposed in this manner. Closely spaced blind drilling has been the chief means of finding and outlining the present ore reserves of the district.

Exploratory drilling on properties southeast of the subject tract has indicated over 100,000 tons of ore in an irregular belt about 3 miles long that roughly parallels the outcrop of the favorable limestone bed (figure 2). This drilling has been confined to those areas near the outcrop where the limestone was overlain with the least overburden, thus permitting open pit mining. It is reported that drilling has indicated about 30,000 tons of ore on Sec. 23 which adjoins the subject property on the east. None of the details of this work were available. Still farther southeast in Sec. 25, about 300 acres bordering the limestone outcrop was drilled on an initial 100-foot grid. This work found 17 separate ore bodies totaling about 61,000 tons, having an estimated average grade of 0.19 percent U_3O_8. These individual ore bodies were scattered at random and varied greatly in shape, thickness and grade. Some of the smaller ones were of the order of 25 feet long and 25 feet wide. The largest covered an area of about 20,000 square feet. The ore, occupying various horizons in the limestone, ranged from 2 to 14 feet in thickness. In the 300 acres drilled, there were large areas covering 40 or more acres in which no ore bodies were found. In the SW¼ of Sec. 30, T. 13 N., R. 9 W., closely spaced drilling of a 60 acre tract indicated 3 ore bodies totaling about 8,800 tons, having an average grade of approximately 0.25 percent U_3O_8.

Thus in the 360 acres for which the results of former drilling are available, it appears that somewhat less than 200 tons of ore was found per acre. However, within that 360 acres there were tracts of the size of the subject property that contained much more than 200 tons of ore per acre and also there were areas of equivalent size (43 acres) that contained no ore at all.

The principal uranium mineral found in the Todilto limestone is tyuyamunite.

PROPOSED EXPLORATION

The applicant's proposals are quoted as follows:

"It is proposed that an initial 100-foot grid of 207 holes, averaging 43.08 feet in depth, be completed first. The disposition of holes on 50 and 25 foot centers shall be determined by the results obtained by the initial grid. Approximately 20 percent of the holes drilled in the central portion of the Grants District have shown gamma ray counts about three times that of the background count of the hole. Applying this ratio 285.66 offset holes on 50 foot centers are anticipated. Ten percent of the holes on 50 feet centers contained 0.05% U_3O_8 or better. On this basis, 213.25 holes on 25 feet centers are anticipated. Several of the mine owners in this district prefer to continue their search for ore on 10 feet centers. It is our opinion that the large additional expense is not warranted by the small pods of uranium found in this manner."

A summary of the applicant's proposal with costs is given below:

Phase	No. Holes	Avg. Depth	Total Feet	Cost/ft.	Total Cost
Initial grid (100 ft.)	207	43.08*	8,919.00	$0.50	4,459.00
Secondary grid (50 ft.)	285.66	43.08	12,305.43	0.50	6,152.715
Tertiary grid (25 ft.)	213.25	43.08			
(a) Limestone Cuttings required		20.00	4,265.00	1.00	4,265.00
(b) Overburden		23.08	4,921.81	0.50	2,460.905
Totals	705.91	43.08	30,410.24		$17,337.62

Radiometric logging and the preparation of a permanent geologic record of every hole: 30,410.24' @ $0.15 - 4,561.36

Supervision, accounting, correspondence, surveying, collection of cuttings, 30 chemical assays of cuttings, radiometric assays of cuttings, geologic mapping and ore reserve calculations:-

30,410.25' @ $0.15 - 4,561.536

Total maximum cost of exploration program - $26,460.69

*Average hole is composed of:
18.08 feet of overburden (alluvium, siltstone and shale)
20.0 feet of limestone (ore horizon)
5.0 feet of sandstone (underlying Entrada sandstone)

The applicant estimated that 207 holes would be required for the initial 100-foot grid. This estimate evidently was based on holes drilled directly on the northern and eastern property line boundaries.

The Field Team believes, in cases such as this where the adjoining property has different ownership and cannot be subordinated, that the initial holes should not be drilled closer than 200 feet from the adjoining ground. If this is adopted in this instance it will reduce the size of the area to be explored by nearly 14 acres, or from 43 to

about 29 acres. As the smaller the tract the less likely it is to contain the average proportion of ore bodies, it is suggested in this case that the initial drilling be started 100 feet from the north and east boundaries of the adjoining property. On this basis the writer recommends the following alternative program:

Stage 1 would consist of drilling the tract with holes spaced 200 feet apart, starting the grid 100 feet south of the north property line and a like distance west of the east side of the tract. This pattern would require 48 holes (figure 3). Holes spaced 200 feet apart would fail to explore an area approaching 40,000 square feet within each 200-foot square. An ore body covering but 10,000 square feet may contain as much as 6,000 tons of ore which is nearly twice the size of the average ore body found by the drilling of 300 acres in sec. 25 (figure 2). Consequently negative results at the end of stage 1 would not necessarily warrant the termination of this project.

Stage 2: Because of the favorable mining conditions prevailing on this property and the relatively small size of the targets, it appears advisable to allow sufficient additional footage under stage 2 so that each initial hole of Stage 1 may be offset on a 100-foot grid pattern (figure 3). Stage 2 would then require an additional 123 holes, none to be drilled closer than 100 feet from the boundary lines of the property.

Stage 3: After the completion of stages 1 and 2, the entire tract will have been drilled on a 100-foot grid pattern. According to Paul Melancon, former Chief of the Atomic Energy Commission's office in Grants, prior drilling experience in the district has indicated that about one sixth of the holes drilled on a 100-foot grid pattern can be expected to warrant offsetting. On this basis, if all the 171 holes of stages 1 and 2 were drilled, about 28.5 of this number could be expected to warrant offset holes, spaced 50 feet apart. Assuming that each of these 28.5 holes will require an average of 6 offsets, then stage 3 would consist of 171 holes drilled on a 50-foot offset pattern in the favorable areas indicated by former holes. This estimated amount of drilling constitutes the allowable maximum. For instance, if only 10 of the holes drilled in stages 1 and 2 were considered worthy of offsetting, then stage 3 would consist of but 60 holes. In case stages 1 and 2 found no holes that would justify offsets, then of course, the project would be terminated. None of stage 3 holes should be drilled closer than 50 feet from the property lines. Any unexpended footage in stage 2 should be transferred to stage 3 upon approval of the Field Team.

Once started, rotary drilling will proceed very rapidly, perhaps as many as 6 holes being completed daily. Just what constitutes a hole worthy of offsetting may in some cases be a difficult problem. Complications with the drilling contractor will arise if his equipment is idle while awaiting decisions. The highly important sampling procedure may be faulty and questions may arise as to the true depth of some of the

holes that have partially caved. To obviate some of the foreseeable difficulties it might be advisable to have a DMEA representative on the job during a large part of the time that the project is under way. Such an arrangement would seem more advisable if 2 DMEA projects were operating in the district at the same time.

The alternative program recommended by the writer is summarized as follows:

Stage 1 -	48 holes on a 200-foot grid;
Stage 2 -	123 holes on a 100-foot offset pattern;
Stage 3 -	171 holes on a 50-foot offset pattern.
Total	342 holes

From figure 3, the distance between the surface and the base of the Todilto limestone was found to average about 37.5 feet. Allowing an additional 3 feet of drilling below the bottom of the limestone to permit probing, the average depth of the holes would be about 40.5 feet. Thus 342 holes would require 13,851 feet of drilling. This amount of exploration would appear adequate for the purpose of disclosing whether or not the property contained worthwhile ore bodies.

If the host limestone underlying the area proposed for exploration averages 20 feet in thickness, then the average depth of overburden would be about 18 feet. For ore found below that amount of overburden, stripping and open-pit mining would be feasible. Under these favorable conditions the mining cost including stripping, as judged from similar operations, would probably not cost more than $8 a ton. If ore averaging 0.20 percent U_3O_8 was found on the property, it would have the following value per ton, f.o.b. mine:

Base price (4 lbs. @ $3.50) ————————	$14.00
Premium (excess over 4 lbs. @ $0.75) ———	None
Development allowance (4 lbs @ $0.50) ———	2.00
Hauling allowance (22 miles @ $0.06) ———	1.32
Total value	$17.32

A bonus amounting to an additional $14.00 a ton would apply on the initial 10,000 pounds of U_3O_8, or in this case on the first 2,500 tons of 0.20 percent ore produced. Thus the average value of the initial 2,500 tons would be $31.32. If a total of 9,000 tons of 0.20 percent ore was found on the property it would have an average value of $21.20. On ore of this value the royalties, consisting of 11 percent to the lessor and 5 percent to the Government, would amount to $3.39 a ton. With operating costs of $8, the resulting profit would be nearly $10 a ton. Hence small ore bodies, under thin overburden, though they contained but a few hundred tons would be profitable and no doubt mined, thus constituting a source of uranium.

It is recognized that an ore body containing but a few hundred tons cannot be considered significant, yet the combined output of all the numerous smaller deposits in the district would be substantial. However, the search for these small average grade deposits by closely spaced drilling is justified only in areas of such shallow overburden as to permit open-pit mining. An experienced operator in the district expressed the opinion that a deposit of average size and grade becomes marginal when covered by more than 35 feet of overburden.

SAMPLING

All the holes drilled under the project should be logged radiometrically and samples collected from the ore-bearing bed as well. An accurate log and the sample results of each hole should be made and recorded by the applicant. In this case the limestone would be sampled in 342 holes by catching the cuttings at each 2-foot interval. If the limestone averaged 20 feet in thickness, 10 samples would be taken from each hole. These samples should be split over a Jones riffle and a representative portion sacked, labeled, and preserved for future checking. The other portion of the sample could be scanned with a calibrated Geiger Counter and those that appeared to be of near ore-grade or better should be assayed.

The applicant proposed assaying all of these samples radiometrically with 20 of the number checked by chemical analyses. It has been shown that the results obtained by radiometric assaying of the limestone ores in the district check very closely with the results obtained by chemical methods. Consequently in this case radiometric assaying of the samples with 20 chemical checks should be satisfactory for the purpose of the proposed exploration.

ESTIMATED COSTS OF THE PROJECT

The applicant proposed that the Four Corners Exploration Co. of Grants be given an independent contract covering all phases of the contemplated exploration. The costs of this complete service as submitted by the above contractor are summarized as follows:

Drilling:

1st 100 feet or any part thereof - $0.50 a foot
2nd 100 feet or any part thereof - 1.00 a foot
Blowing hole clean and catching cuttings every 2 feet - $0.50 a foot extra over regular prices.
Radiometric logging and preparation of a permanent geologic record of every hole: - $0.15 a foot. Supervision, accounting, correspondence, surveying, collection of samples, 20 chemical assays of cuttings, radiometric assay cuttings, geologic mapping and ore reserve calculations: - $0.15 a foot.

These prices appear reasonable and so far as the drilling is concerned, they are competitive with other contracts in the district.

The average depth of the proposed holes was calculated from the Atomic Energy Commission's topographic map of the area, and structural contours which were based on the presumption that the average dip of the limestone was about 10 feet vertically in 140 feet horizontally (figure 3). From these data the depth of the proposed holes was found to average 37.5 feet. An additional 3 feet of drilling below the base of limestone is desirable in order to afford space for any caving that might occur before the hole could be probed with the radiometric logging device. The applicant desired an extra 5 feet of drilling for this purpose but in the case of such relatively shallow holes it would seem that 3 feet would be sufficient. Thus by allowing 3 feet of extra drilling below the base of the limestone the average depth of the holes would be about 40.5 feet.

Based on the foregoing bid of the Four Corners Exploration Co. the estimated cost of the alternative program would be as follows:

Stage	Grid Pattern	Number of Holes	Depth, Feet	Total Feet	Price per Foot	Cost
1	200 feet	48	40.5	1,944	$0.50	$972.00
2	100 feet	123	40.5	4,981.5	0.50	2,490.75
3	50 feet	171	40.5	6,925.5	0.50	3,462.75
	Totals	342		$13,851.0		$6,925.50

Sampling: 342 holes over 20 ft. thickness = 6,840 ft. @ $0.50	3,420.00
Radiometric logging - 13,851. ft. @ $0.15	2,077.65
All other costs - 13,851 ft. @ $0.15	2,077.65
Total	$14,500.80
Average cost per foot	$1.05

Working continuously 26 days a month with an average footage of 250 feet per day the drilling could be completed in slightly over 2 months.

PROPOSED FINANCING

The project as estimated by the writer would cost $14,500 of which the applicant would furnish 10 percent, or $1,450 and the Government would provide $13,050.

The ore produced from neighboring properties has averaged about $22 a ton. With ore of this value and a 5 percent royalty the subject property would have to produce about 11,860 tons of ore in order to repay the Government loan. Judged by the information available, the tonnage indicated by the drilling on neighboring properties has averaged about 200 tons of ore per acre. On that basis the 43 acres in question could be expected to yield 8,600 tons of ore. However, because of the unpredictable erratic distribution of the deposits, the subject property could contain more than 8,600 tons, and likewise could contain much less.

CONCLUSIONS AND RECOMMENDATIONS

The productive limestone throughout the area is for the most part completely covered with alluvium or younger sediments so that the only means available for judging the merits of an unexplored tract is its location to known trends and/or its proximity to known ore bodies. The subject property lies within the projected trend of an irregular belt of the Todilto limestone in which ore has been found on neighboring properties and for that reason it is considered worthy of exploration.

The ore-bearing bed underlying the area proposed for exploration is covered with such a thin matte of overburden that any ore found could be mined cheaply in open pits. This would permit the production of uranium from smaller and lower-grade ore bodies than would be economically feasible where a large amount of stripping or underground mining was necessary. Consequently in areas of shallow overburden, such as the tract in question, there is justification for closely spaced drilling in order to discover as many as possible of the smaller, yet profitable ore bodies.

The applicant proposed to award the drilling contract to the Four Corners Exploration Co. This company is a newly formed organization owned jointly by F. O. Manel and Irving Rapaport, both of Grants, N. Mex.

Rapport is a graduate geologist with about 4 years experience in uranium exploration. He was employed about 3 years of that time by the Atomic Energy Commission as project supervisor in Utah and New Mexico. For the past year he has been managing the exploration and mining operations of the Hanosh Mines, Inc. F. O. Manel, the other partner, has been exploiting a uranium property in the Grants district for the past year and a half with considerable success. The equipment belonging to the Four Corners Exploration consisted of a Failing 1500 mobile rotary drilling rig with auxilliary air compressor and Duclone sampler. A truck mounted radiometric hole logging unit had been ordered and delivery was expected late in October 1953. Whether or not it is available at this time is not known.

As there appears to be a reasonable chance of finding ore on the subject property it is recommended that a loan amounting to $14,500 be approved. A short form contract is suggested specifying a maximum of 13,850 feet of drilling at a price of $1.05 a foot.

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
WASHINGTON 25, D. C.

224 New Customhouse
Denver 2, Colorado

August 27, 1954.

Memorandum

To: Secretary to the Operating Committee, DMEA

From: Executive Officer, DMEA Field Team, Region IV

Subject: Docket No. DMEA-3152 (Uranium), Hanosh Mines, Inc., McKinley County, New Mexico.

Enclosed are four copies of the report of field examination on the subject application and two copies of Form 3b.

This docket has been closed by this office effective August 16, 1954 because the applicant has not provided an approved Assignment of Lease.

W. H. King

Enclosures

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

Mining Division
Region IV

March 3, 1954.

Memorandum

To: Field Team, Region IV

From: Chief, Mining Division, Region IV

Subject: Report of Examination - DMEA Docket 3152 (Uranium), Hanosh Mines, Inc., McKinley County, New Mexico.

Enclosed are eleven copies of the engineering report of examination on the subject docket.

The applicant requested $26,460.69 to drill the property on a scale which appears to be too ambitious to the examining engineer.

The examining engineer recommends a drilling program to be divided into three stages, the work to consist of 342 holes averaging 40.5 feet in depth at an estimated total cost of $13,851.00.

We concur in this recommendation.

W H King

W. H. King

Enclosures

February 19, 1954

Memorandum

To : W. H. King, Chief, Mining Division, Region IV

From : Chief, Mining Methods Br., Mining Div., Region IV

Subject : Engineering Report on Docket DMEA-3152, Hanosh Mines, Inc., Uranium Property, McKinley County, N. Mex.

Enclosed are original and 9 copies of a revised report by Lloyd L. Farnham of the Bureau of Mines on the above property. The other copy will be forwarded to you by R. P. Fischer of the Geological Survey's Grand Junction office. J. D. Strobell of the Geological Survey has read and approved this report by Farnham.

The DMEA field examiners recommend that Hanosh Mines, Inc. be granted exploration assistance to drill its property north of Grants, N. Mex. I concur with this recommendation.

Walter R. Storms

Walter R. Storms

cc: W. H. King (10)
R. P. Fischer
DMEA-3152
DF

WRStorms:frj

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Defense Minerals Exploration Administration
Denver Federal Center
Denver 2, Colorado

February 23, 1954

Memorandum

To: DMEA Field Team, Region IV

From: A. H. Koschmann

Subject: DMEA Docket 3152, Hanosh Mines, Inc., McKinley County, New Mexico

Enclosed are 11 copies of a geologic report by J. D. Strobell, Jr., of the U. S. Geological Survey covering the above docket.

The recommended plan of exploration has been revised to agree with that suggested by Lloyd Farnham of the Bureau of Mines office in Tucson, as requested by the Field Team in December.

A. H. Koschmann

A. H. Koschmann
Supervising Geologist
Colorado-Wyoming

Enclosures (11)

C
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P
Y

UNITED STATES
DEPARTMENT OF THE INTERIOR
Geological Survey
P. O. Box 360
Grand Junction, Colo.

February 24, 1954.

Memorandum

To: W. H. King, DMEA Field Team, Region IV

From: R. P. Fischer, Colorado Plateau District

Subject: DMEA 3152, Hanosh Mines, Inc., Uranium Property, McKinley County, New Mexico.

Forwarded herewith is carbon copy of Farnham's report, DMEA 3152, Hanosh Mines, Inc., Uranium Property, McKinley County, New Mexico, as requested by Storms in his memorandum of February 17.

/s/ R. P. Fischer
District Supervisor

Enclosure

C
O
P
Y

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
P. O. Box 360
Grand Junction, Colo.

February 19, 1954.

MEMORANDUM

TO: A. H. Koschmann, Field Team, Region IV

From: R. P. Fischer, Supervisor,
Colorado Plateau District

Subject: DMEA 3152, Hanosh Mines, Inc., McKinley County, New Mexico

Transmitted herewith are 11 copies of Strobell's revised report on the above application. The recommended plan of exploration has been revised to agree with that suggested by Lloyd Farnham of the Bureau of Mines office in Tucson, as requested by the Field Team in December.

Enclosures 11

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
P. O. BOX 360
GRAND JUNCTION, COLORADO

October 9, 1953

Memorandum

To: A. H. Koschmann, DMEA Field Team, Region IV

From: R. P. Fischer, Acting Supervisor
Colorado Plateau District

Subject: DMEA 3152, Hanosh Mines, Inc., McKinley County, New Mexico

Transmitted herewith are eleven copies of a geologic report on the ground leased by the Hanosh Mines, Inc., McKinley County, N. Mex. The company applied for assistance in exploring for uranium; they propose to do 30,410 feet of drilling and related work at an estimated cost of $26,460.69.

The attached report is prepared by J. D. Strobell, Jr., and is based on a joint field examination on September 15 with Lloyd Farnham, USBM, and Irving Rapaport, representing the applicants. The examining team also conferred with P. E. Melancon, AEC geologist, who is in general agreement with the conclusions and recommendations offered in the report.

Strobell concludes that exploration in the area has a good chance of finding 6,000 to 9,000 tons of ore, and thus is favorable for exploration. On this basis, he recommends an exploration contract, pointing out at the same time, however, that the value of the ore expected probably will not be sufficient to repay through royalty payments the entire cost to the government. A program of ~~15,000~~ feet of drilling, smaller than that proposed by the applicant, is suggested. 13,851

I concur with these conclusions and the suggested plan of exploration.

R. P. Fischer

R. P. Fischer
Acting District Supervisor

Enclosures 11

RPF/mlr

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

In August 1953, Hanosh Mines, Inc. applied to the Defense Minerals Exploration Administration, under the Defense Production Act of 1950, as amended, for an exploration loan amounting to $26,460.69. The application was docketed as DMEA-3152. The funds requested were to be used in the exploratory drilling of a uranium prospect situated in the Grants district of northwestern New Mexico. The property was examined[1] on September 15, 1953.

Extensive exploration has been under way in the Grants region since 1950 when the presence of uranium first was detected. The deposits occur as sporadic, irregular, blanket-type replacements in the Todilto limestone and also in some of the overlying formations. The Todilto in the Grants area is a persistent gently dipping (4°) bed about 20 feet in thickness which owing to its relative resistance to erosion, usually caps many of the lower benches and mesas along the valley floors.

The project property covers an unexplored area of about 43 acres that is underlain by this ore-bearing limestone. Except in the immediate vicinity of the outcrop the favorable bed is usually completely covered with varying amounts of soil and younger sediments, which increase progressively in thickness down the dip of the limestone. This mantle of overburden not only covers the area proposed for exploration but prevails generally throughout the district. Structural controls or other ore-guides usually are lacking so that closely spaced

1/ Farnham, L. L., Mining Engineer, Bureau of Mines; Strobell, J. D., Geologist, Geological Survey

blind drilling has been, and still is the only practical means of discovering ore in the district. Exploratory drilling of this nature has found important, but sporadic ore bodies occupying an irregular belt that extends for about 3 miles to the southeast and for some 4 miles west of the subject property.

The applicant proposed to explore the 43-acre tract by 30,410 feet of rotary drilling in 706 holes, spaced from 100 to 25 feet apart. This work was estimated to cost $26,460.69. As this amount of drilling appeared excessive for the purpose of exploration, an alternative program was recommended which involved 13,850 feet of drilling in 342 holes at an estimated cost of $14,500.

The area proposed for exploration is favorably situated in respect to a productive trend and for that reason it appears to be worthy of exploration. Therefore, it is recommended that a loan amounting to not more than $14,500 be approved.

UNITED STATES DEPARTMENT OF THE INTERIOR
DOUGLAS McKAY, SECRETARY

DEFENSE MINERALS EXPLORATION ADMINISTRATION

REPORT OF EXAMINATION BY FIELD TEAM
REGION IV

DMEA 3152, Hanosh Mines, Inc.,

Section 22, T. 13 N., R. 10 W., Grants District,

McKinley County, New Mexico

Uranium

Geologic report

J. D. Strobell, Jr., Geologist
U. S. Geological Survey

October 9, 1953

HANOSH MINES, INC.,
McKINLEY COUNTY, NEW MEXICO

INTRODUCTION AND SUMMARY

Application has been made by Hanosh Mines, Inc., for government assistance (DMEA 3152) in exploring for uranium in the Todilto limestone of the Grants District, McKinley County, N. Mex. The applicant proposes 30,410 feet of drilling, at an estimated cost of $26,460.69, to explore about 45 acres in the NE ¼, sec. 22, T. 13 N., R. 10 W. The property was examined on September 15, by Lloyd Farnham of the U. S. Bureau of Mines, Tucson, Ariz., and J. D. Strobell, Jr., of the U. S. Geological Survey, Grand Junction, Colo. The examiners were accompanied by the applicant's representative, Mr. Irving Rapaport, and conferred also with Mr. P. E. Melancon, District Geologist of the U. S. Atomic Energy Commission, Grants, N. Mex.

The property lies on allotted Indian lands. Prospecting and mining rights are leased to the applicant with the approval and under the general supervision of the Bureau of Indian Affairs, U. S. Department of the Interior. Royalties stipulated by that Bureau range from 10 to 20 percent of the mine value of the ore (excluding allowances for development and transportation) and include in addition 10 percent of any bonuses paid by the U. S. Atomic Energy Commission.

A somewhat curtailed program (about 50 percent reduction) to explore this property with government assistance is recommended. The applicant's proposal is considered to carry the exploration too far into the development phase not appropriately a part of DMEA exploration. A maximum of ~~15,000~~ 13,851 feet of drilling in primary and offset holes is recommended. It is also suggested that in addition to the radiometric logging of these holes proposed by the applicant, collection of cuttings from the limestone be required until such time as the reliability of radiometric logging is definitely established in the district.

GEOLOGY

In the Grants district, uranium deposits occur in the Todilto limestone and Morrison sandstone beds of Jurassic age, and in the overlying Cretaceous rocks. The Hanosh lease in sec. 22 covers an area underlain by the Todilto limestone. The Todilto caps cliffs of the underlying Entrada sandstone and forms a broad bench where the overlying Summerville formation has been removed by erosion. It dips very gently northeastward across the property and is covered by a veneer of dune sand and alluvium up to about 50 feet thick, which may also locally conceal remnants of the Summerville formation. Except along the rim at the top of the Entrada cliff, the limestone is completely covered on the Hanosh property. Near the northern edge of the property increasing amounts of the silty sandstone of the Summerville formation are likely to be present. The limestone is about 20 feet thick on the average, and the applicant states that the overburden on the property averages only 18 feet in thickness.

ORE DEPOSITS

In the Grants district, uraniferous minerals locally coat bedding planes and joint surfaces of the limestone, are disseminated in blebs and crystals, and are associated with coarsely crystalline carbonates in veinlets. Among the important ore minerals are tyuyamunite, carnotite, uranophane, and uraninite. These minerals are locally present in sufficient amounts to form ore bodies of irregular plan and thickness without sharply defined limits. Controls of their localization are not well understood. The ore bodies occur at all positions between the top and bottom of the limestone. There is evidence of their localization along the axial portion of minor folds, but not all such folds are mineralized. This produces elongated ore bodies, as does localization on dominant joints. The ore bodies range in size from small tabular masses covering a few square feet to large bodies several hundred feet across. The thickness ranges from 1 foot or less up to about 14 feet. Most of the ore bodies are small elongated masses containing less than 2 or 3 thousand tons. The average grade of the ore shipped ranges from .20 to about .25 percent U_3O_8, and rarely up to .35 percent U_3O_8.

The applicant has developed no ore on this property. There are two showings of uranium mineralization on the rim exposures, and one near the northwest corner of the section that is in a limestone lens near the base of the Summerville formation. The nearest known ore is that discovered in the southern part of sec.23 by the Santa Fe Railroad and in the northern part of sec. 26 by the applicant. Several ore bodies have been found farther southeast in secs. 25, 30, and 31.

In these several sections, the known ore bodies are estimated to contain from 25 to more than 10,000 tons of ore apiece. The average ore body contains on the order of 3,000 tons. The size and distribution of these known deposits might be considered representative of the deposits expected in the area to be explored. The known ore bodies total about 40 in number, and were found by exploration of a combined area about 1.25 square miles in extent. It therefore seems possible that exploration of the applicant's 45 acres (.07 square mile) might discover 2 or 3 deposits that might contain as much as 6,000 to 9,000 tons of ore.

The value of this ore (before initial production bonus and haulage allowance), assuming an average grade between .20 and .25 percent U_3O_8, would range from $16.00 to $20.75 per ton. The value of the anticipated discoveries would therefore expectably be between $96,000 and $186,750.

The known ore bodies range in size from less than 25 feet in diameter up to 100x800 feet. Their small size and irregular shape make them difficult targets for exploration, but where they lie at shallow depths many small ore bodies can and will be mined at a profit. Closely spaced drilling therefore seems justifiable in shallow ground such as the area under consideration.

PROPOSED EXPLORATION

The exploration proposed by the applicant consists of a maximum of 30,410 feet of rotary drilling estimated to cost $26,460.69. It is proposed to do the drilling in three stages: (1) An initial grid of 207 holes (8,919 feet) spaced 100 feet apart to test the whole area; (2) a secondary grid of 286 holes (12,306 feet) consisting of 8 off-set holes spaced 50 feet apart around one initial hole in five; and (3) a tertiary grid of 213 holes (9,186 feet) consisting of 8 off-set holes spaced 25 feet apart around one secondary hole in ten. Radiometric logging would be used to determine which of the initial and secondary holes should be offset. Samples would be collected only from the holes drilled on 25-foot centers, and these samples would be tested radiometrically to determine the grade of the rock cut in drilling. Chemical assays would be made of a few of the samples to check the radiometric determinations.

The field examiners believe the area is favorable for finding uranium deposits, but that the applicant proposed more drilling than is needed for exploration. The following modified program is suggested:

Stage 1: The entire area should be tested with an initial pattern of holes spaced 200 feet apart, beginning 100 feet south of the north boundary line and 100 feet west of the east boundary line. This stage will require 48 holes, averaging 40.5 feet deep for a total of 1944 feet. Although this initial test would find only unusually large deposits, it will test for the presence of the ore-bearing limestone and may by chance find some small deposits. It does not in itself constitute an adequate test of the property because of the small size and narrow elongate shape of the typical deposits.

Stage 2: The second phase of the exploration should, therefore, provide sufficient footage to complete a 100-foot grid pattern, no holes to be drilled within 100 feet of the north and east property lines. Experience has shown that holes drilled on this pattern will indicate the presence of most deposits of average size, and would be accepted as a fair test of the property in the event of completely negative results. This stage will require 123 holes. Assuming they also average 40.5 feet in depth, they would total 4981.5 feet of drilling.

Stage 3: According to P. E. Melancon, AEC geologist, experience in the district indicates that one hole in six drilled on 100-foot centers will cut rock having enough radioactivity to justify off-setting. On this basis 28.5 of the holes drilled in Stages 1 and 2 might require additional holes to test the adjacent ground. Allowing 6 offset holes for each of these 28.5 holes, 171 holes should be provided for in Stage 3. These holes should be spaced 50 feet apart, and may be drilled 50 feet from the property lines. The suggested allowable maximum footage for Stage 3 is 6925.5.

It is further suggested that Stage 1 and Stage 2 holes be completed and their relative favorability be determined before the Stage 3 offset holes are drilled. In this way, the whole area can be appraised and the most favorable parts can be selected for further testing by offset drilling.

This program, totalling 13,851 feet of drilling, presents allowable maximum footages. By beginning with 200-foot spacing in Stage 1, it is possible that some parts of the area can be eliminated from further consideration, thus saving a few holes in stage 2. It is also possible that all of the allowable footage in Stage 3 might not be needed to test whatever favorable indications are obtained in Stages 1 and 2. On the other hand, in the event of many favorable showings, it is desirable to allow the use of unexpended Stage 2 footage in Stage 3. In this way, within the allowable maximum under the contract, some flexibility is obtained even though the program is organized in stages.

No drilling on 25-foot centers, as proposed by the applicant, is suggested, as it is believed that drilling on 100-foot centers with some 50-foot offsets will find most average sized deposits or at least suggest their proximity. Closer spaced drilling, however, probably would be required to obtain a reasonably accurate appraisal of the tonnage and grade of deposits and certainly would be required to develop them for mining. It is believed that the applicant should be willing to do at his own expense the work he considers necessary to develop ore for mining if the greater risks of exploration have already been taken in the DMEA project.

The applicant has proposed to take no samples from the holes drilled on 100- and 50-foot centers, but rather to rely upon radiometric determinations by in-hole logging equipment to select the holes to be offset. Although the AEC field personnel have recommended this practice, and it has been accepted by the DMEA examining team for use on projects already studied, a more critical analysis of the logging method shows that it has not been thoroughly tested and proved. Furthermore, the AEC does not have the capacity to do the radiometric logging on this project whereas they have promised to do it on other DMEA projects, and the applicant proposes instead to use unproved logging equipment. The examining team therefore recommends that, in addition to the proposed radiometric hole logging, samples of the drill cuttings representing 2-foot intervals throughout the Todilto limestone be taken from all drill holes. This sampling will of course increase the cost of the project, but it seems necessary for the present in order to ensure obtaining adequate guidance for the drilling and to establish the reliability of the logging equipment.

Experience in the Grants district has shown that the uranium ore in the limestone is essentially in radioactive equilibrium and that radiometric determinations with laboratory scalers or even with simple portable counters can be used, if the instruments are properly calibrated and checked, to determine the grade of samples. The applicant proposes to use radiometric determinations for assaying samples; 20 chemical assays of samples selected at random are also proposed as checks. The proposed plan of radiometric assaying with 20 chemical assays for checking is considered sound and should be acceptable to DMEA. All drill holes, however, should be sampled as suggested above.

CONCLUSIONS AND RECOMMENDATIONS

Exploration of the Hanosh property in sec. 22, T. 13 N., R. 10 W., McKinley County, N. Mex., by rotary drilling appears to have a favorable chance of finding as much as 6,000 to 9,000 tons of ore containing 0.20 to 0.25 percent U_3O_8. At the present price schedule, this ore will have a value of $96,000 to $186,750, which is probably not sufficient to repay completely the government's share of the cost of exploration. On the basis that the ground offers the chance of finding a significant amount of ore, however, it is recommended that the government enter into a contract for a maximum of ~~15,000~~ 13,851 feet of drilling to cover a primary ~~100~~ 200-foot grid, a secondary 100-foot grid, and about ~~140~~ 171 off-set holes at 50-foot spacing. It is desirable to use in-hole radiometric logging as proposed by the applicant, but cuttings should be collected through the limestone in all holes and selected samples checked by radiometric assay in order to establish the reliability of the technique. A few chemical assays should be provided to check the grade of possible discoveries.

DMEA-3152, HANOSH MINES, INC., URANIUM PROPERTY
McKINLEY COUNTY, NEW MEXICO

Engineering Report

By L. L. Farnham, Mining Engineer
U. S. Bureau of Mines

February 1954

DMEA-3152, HANOSH MINES, INC., URANIUM PROPERTY
McKINLEY COUNTY, NEW MEXICO

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INTRODUCTION

Late in August 1953, Hanosh Mines, Inc., applied to the Defense Minerals Exploration Administration under the Defense Production Act of 1950, as amended, for an exploration loan amounting to $26,460.69. The application was docketed as DMEA-3152. The funds requested were to be used in search of uranium deposits by means of 30,410 feet of rotary drilling.

The property was visited by the DMEA examiners[1/] on September 15, 1953. The initial engineering report, submitted in October 1953, has been revised in this report in accordance with recent policy decisions.

ACKNOWLEDGMENTS

Acknowledgments are made to Paul E. Melancon, formerly of the Atomic Energy Commission, and to Irving Rapaport for their assistance during the examination.

LOCATION AND PHYSICAL FEATURES

The property is situated about 19 miles north of the town of Grants in the NE$\frac{1}{4}$ of Sec. 22, T. 13 N., R. 10 W., McKinley County, N. Mex. It can be reached by traveling west of Grants on U. S. Highway 66 for 3.2 miles, thence northward on State Highway 53 for 10.8 miles to a side road branching westward. The site of the proposed project is reached by proceeding about 4 miles in a northwesterly direction on this branch road (figure 1). The subject property is 22 miles from the uranium processing plant of the Anaconda Copper Mining Co. near Bluewater.

1/ Strobell, J. D., Geologist, Geological Survey;
Farnham, L. L., Mining Engineer, Bureau of Mines.

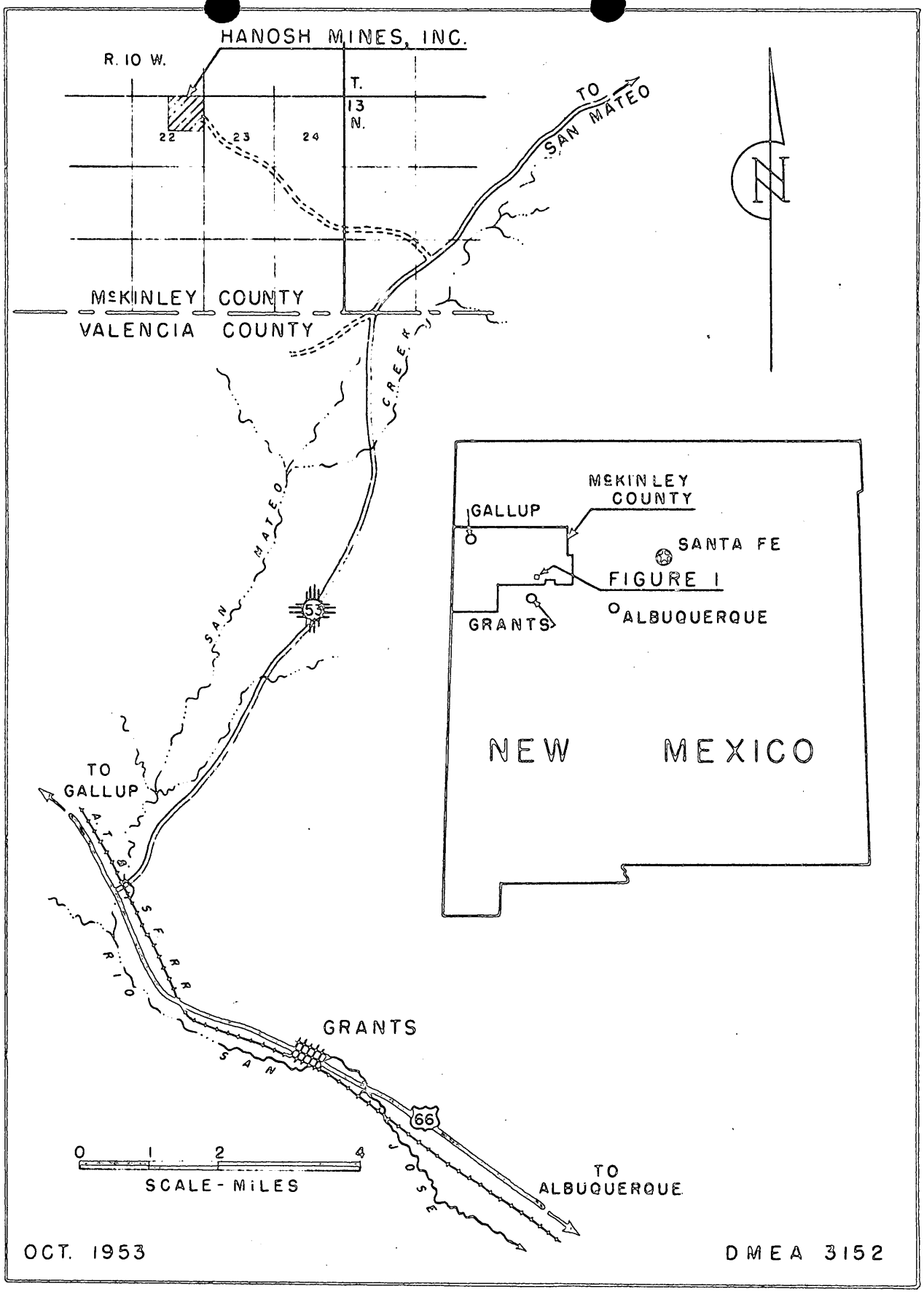

FIGURE 1, - LOCATION MAP - HANOSH MINES, INC.
McKINLEY COUNTY, NEW MEXICO

The area proposed for exploration is situated on a relatively flat, gently-sloping alluvium-covered bench or mesa. Altitudes above sea level range from a high of 7,120 feet at the southeast corner of the tract to a low of 7,050 feet at the northeast corner.

HISTORY AND PRODUCTION

The first mining activity in the Grants district began in 1950, following the initial discovery of uranium near Haystack Butte (figure 2). These deposits, situated about 4 miles west of the subject property, have proven to be the largest found to date in the district. Large scale production from this area is awaiting the completion of the Anaconda plant near Bluewater. The applicant's property, valuable only for grazing prior to the discovery of uranium in the region, has not been explored. Drilling on contiguous tracts, southeast of that held by the applicant, has disclosed important deposits. Four properties in this area were in production at the time of the examination.

OWNERSHIP AND EXTENT

The applicant, reportedly holds a lease on the NE$\frac{1}{4}$ of Sec. 22, T. 13 N., R. 10 W., McKinley County, N. Mex. This property is an Indian allotment and as such is under the jurisdiction of the Bureau of Indian Affairs of the Department of the Interior. A copy of the applicant's lease is not available. It is the writer's understanding that the royalty payments stipulated in the lease are based on a sliding scale starting at 10 percent for ore with a mill value of $20 a ton and increasing one percent for each $10 in added value. Under the lease, royalty is payable on all bonuses, premiums and other allowances received by the shipper.

Exploratory drilling on properties southeast of the subject tract has indicated over 100,000 tons of ore in an irregular belt about 3 miles long that roughly parallels the outcrop of the favorable limestone bed (figure 2). This drilling has been confined to those areas near the outcrop where the limestone was overlain with the least overburden, thus permitting open pit mining. It is reported that drilling has indicated about 30,000 tons of ore on Sec. 23 which adjoins the subject property on the east. None of the details of this work were available. Still farther southeast in Sec. 25, about 300 acres bordering the limestone outcrop, was drilled on an initial 100-foot grid. This work found 17 separate ore bodies totaling about 61,000 tons, having an estimated average grade of 0.19 percent U_3O_8. These individual ore bodies were scattered at random and varied greatly in shape, thickness and grade. Some of the smaller ones were of the order of 25 feet long and 25 feet wide. The largest covered an area of about 20,000 square feet. The ore, occupying various horizons in the limestone, ranged from 2 to 14 feet in thickness. In the 300 acres drilled, there were large areas covering 40 or more acres in which no ore bodies were found. In the SW$\frac{1}{4}$ of Sec. 30, T. 13 N., R. 9 W., closely spaced drilling of a 60 acre tract indicated 3 ore bodies totaling about 9,000 tons, having an average grade of approximately 0.25 percent U_3O_8.

Thus in the 360 acres for which the results of former drilling are available, it appears that somewhat less than 200 tons of ore was found per acre. However, within that 360 acres there were tracts of the size of the subject property that contained much more than 200 tons of ore per acre and also there were areas of equivalent size (43 acres) that contained no ore at all.

The principal uranium mineral found in the Todilto limestone is tyuyamunite.

PROPOSED EXPLORATION

The applicant's proposals are quoted as follows:

"It is proposed that an initial 100-foot grid of 207 holes, averaging 43.08 feet in depth, be completed first. The disposition of holes on 50 and 25 foot centers shall be determined by the results obtained by the initial grid. Approximately 20 percent of the holes drilled in the central portion of the Grants District have shown gamma ray counts about three times that of the background count of the hole. Applying this ratio 285.66 offset holes on 50 foot centers are anticipated. Ten percent of the holes on 50 foot centers contained 0.05% U_3O_8 or better. On this basis, 213.25 holes on 25 foot centers are anticipated. Several of the mine owners in this district prefer to continue their search for ore on 10 foot centers. It is our opinion that the large additional expense is not warranted by the small pods of uranium found in this manner."

A summary of the applicant's proposal with costs is given below:

Phase	No. Holes	Avg. Depth	Total Feet	Cost/ft.	Total Cost
Initial grid (100 ft.)	207	43.08*	8,919.00	$0.50	4,459.00
Secondary grid (50 ft.)	285.66	43.08	12,305.43	0.50	6,152.715
Tertiary grid (25 ft.)	213.25	43.08			
(a) Limestone Cuttings required		20.00	4,265.00	1.00	4,265.00
(b) Overburden		23.08	4,921.81	0.50	2,460.905
Totals	705,91	43.08	30,410.24		$17,337.62

Radiometric logging and the preparation of a permanent geologic record of every hole: 30,410.24' @ $0.15 - 4,561.36

Supervision, accounting, correspondence, surveying, collection of cuttings, 20 chemical assays of cuttings, radiometric assays of cuttings, geologic mapping and ore reserve calculations:-

30,410.25' @ $0.15 - 4,561.536

Total maximum cost of exploration program - $26,460.69

*Average hole is composed of:
18.08 feet of overburden (alluvium, siltstone and shale)
20.0 feet of limestone (ore horizon)
5.0 feet of sandstone (underlying Entrada sandstone)

The applicant estimated that 207 holes would be required for the initial 100-foot grid. This estimate evidently was based on holes drilled directly on the northern and eastern property line boundaries.

The Field Team believes, in cases such as this where the adjoining property has different ownership and cannot be subordinated, that the initial holes should not be drilled closer than 200 feet from the adjoining ground. If this is adopted in this instance it will reduce the size of the area to be explored by nearly 14 acres, or from 43 to

about 29 acres. As the smaller the tract the less likely it is to contain the average proportion of ore bodies, it is suggested in this case that the initial drilling be started 100 feet from the north and east boundaries of the adjoining property. On this basis the writer recommends the following alternative program:

Stage 1 would consist of drilling the tract with holes spaced 200 feet apart, starting the grid 100 feet south of the north property line and a like distance west of the east side of the tract. This pattern would require 48 holes (figure 3). Holes spaced 200 feet apart would fail to explore an area approaching 40,000 square feet within each 200-foot square. An ore body covering but 10,000 square feet may contain as much as 6,000 tons of ore which is nearly twice the size of the average ore body found by the drilling of 300 acres in sec. 25 (figure 2). Consequently negative results at the end of stage 1 would not necessarily warrant the termination of this project.

Stage 2: Because of the favorable mining conditions prevailing on this property and the relatively small size of the targets, it appears advisable to allow sufficient additional footage under stage 2 so that each initial hole of Stage 1 may be offset on a 100-foot grid pattern (figure 3). Stage 2 would then require an additional 123 holes, none to be drilled closer than 100 feet from the boundary lines of the property.

Stage 3: After the completion of stages 1 and 2, the entire tract will have been drilled on a 100-foot grid pattern. According to Paul Melancon, former Chief of the Atomic Energy Commission's office in Grants, prior drilling experience in the district has indicated that about one sixth of the holes drilled on a 100-foot grid pattern can be expected to warrant offsetting. On this basis, if all the 171 holes of stages 1 and 2 were drilled, about 28.5 of this number could be expected to warrant offset holes, spaced 50 feet apart. Assuming that each of these 28.5 holes will require an average of 6 offsets, then stage 3 would consist of 171 holes drilled on a 50-foot offset pattern in the favorable areas indicated by former holes. This estimated amount of drilling constitutes the allowable maximum. For instance, if only 10 of the holes drilled in stages 1 and 2 were considered worthy of offsetting, then stage 3 would consist of but 60 holes. In case stages 1 and 2 found no holes that would justify offsets, then of course, the project would be terminated. None of stage 3 holes should be drilled closer than 50 feet from the property lines. Any unexpended footage in stage 2 should be transferred to stage 3 upon approval of the Field Team.

Once started, rotary drilling will ppoceed very rapidly, perhaps as many as 6 holes being completed daily. Just what constitutes a hole worthy of offsetting may in some cases be a difficult problem. Complications with the drilling contractor will arise if his equipment is idle while awaiting decisions. The highly important sampling procedure may be faulty and questions may arise as to the true depth of some of the

holes that have partially caved. To obviate some of the foreseeable difficulties it might be advisable to have a DMEA representative on the job during a large part of the time that the project is under way. Such an arrangement would seem more advisable if 2 DMEA projects were operating in the district at the same time.

The alternative program recommended by the writer is summarized as follows:

Stage 1 -	48 holes on a 200-foot grid;
Stage 2 -	123 holes on a 100-foot offset pattern;
Stage 3 -	171 holes on a 50-foot offset pattern.
Total	342 holes

From figure 3, the distance between the surface and the base of the Todilto limestone was found to average about 37.5 feet. Allowing an additional 3 feet of drilling below the bottom of the limestone to permit probing, the average depth of the holes would be about 40.5 feet. Thus 342 holes would require 13,851 feet of drilling. This amount of exploration would appear adequate for the purpose of disclosing whether or not the property contained worthwhile ore bodies.

If the host limestone underlying the area proposed for exploration averages 20 feet in thickness, then the average depth of overburden would be about 18 feet. For ore found below that amount of overburden, stripping and open-pit mining would be feasible. Under these favorable conditions the mining cost including stripping, as judged from similar operations, would probably not cost more than $8 a ton. If ore averaging 0.20 percent U_3O_8 was found on the property, it would have the following value per ton, f.o.b. mine:

Base price (4 lbs. @ $3.50) ----------	$14.00
Premium (excess over 4 lbs. @ $0.75) ------	None
Development allowance (4 lbs @ $0.50) -----	2.00
Hauling allowance (22 miles @ $0.06) ------	1.32
Total value	$17.32

A bonus amounting to an additional $14.00 a ton would apply on the initial 10,000 pounds of U_3O_8, or in this case on the first 2,500 tons of 0.20 percent ore produced. Thus the average value of the initial 2,500 tons would be $31.32. If a total of 9,000 tons of 0.20 percent ore was found on the property it would have an average value of $21.20. On ore of this value the royalties, consisting of 11 percent to the lessor and 5 percent to the Government, would amount to $3.39 a ton. With operating costs of $8, the resulting profit would be nearly $10 a ton. Hence small ore bodies, under thin overburden, though they contained but a few hundred tons would be profitable and no doubt mined, thus constituting a source of uranium.

It is recognized that an ore body containing but a few hundred tons cannot be considered significant, yet the combined output of all the numerous smaller deposits in the district would be substantial. However, the search for these small average grade deposits by closely spaced drilling is justified only in areas of such shallow overburden as to permit open-pit mining. An experienced operator in the district expressed the opinion that a deposit of average size and grade becomes marginal when covered by more than 35 feet of overburden.

SAMPLING

All the holes drilled under the project should be logged radiometrically and samples collected from the ore-bearing bed as well. An accurate log and the sample results of each hole should be made and recorded by the applicant. In this case the limestone would be sampled in 342 holes by catching the cuttings at each 2-foot interval. If the limestone averaged 20 feet in thickness, 10 samples would be taken from each hole. These samples should be split over a Jones riffle and a representative portion sacked, labeled, and preserved for future checking. The other portion of the sample could be scanned with a calibrated Geiger Counter and those that appeared to be of near ore-grade or better should be assayed.

The applicant proposed assaying all of these samples radiometrically with 20 of the number checked by chemical analyses. It has been shown that the results obtained by radiometric assaying of the limestone ores in the district check very closely with the results obtained by chemical methods. Consequently in this case radiometric assaying of the samples with 20 chemical checks should be satisfactory for the purpose of the proposed exploration.

ESTIMATED COSTS OF THE PROJECT

The applicant proposed that the Four Corners Exploration Co. of Grants be given an independent contract covering all phases of the contemplated exploration. The costs of this complete service as submitted by the above contractor are summarized as follows:

Drilling:

1st 100 feet or any part thereof - $0.50 a foot
2nd 100 feet or any part thereof - 1.00 a foot
Blowing hole clean and catching cuttings every 2 feet - $0.50 a foot extra over regular prices.
Radiometric logging and preparation of a permanent geologic record of every hole: - $0.15 a foot. Supervision, accounting, correspondence, surveying, collection of samples, 20 chemical assays of cuttings, radiometric assay cuttings, geologic mapping and ore reserve calculations: - $0.15 a foot.

These prices appear reasonable and so far as the drilling is concerned, they are competitive with other contracts in the district.

The average depth of the proposed holes was calculated from the Atomic Energy Commission's topographic map of the area, and structural contours which were based on the presumption that the average dip of the limestone was about 10 feet vertically in 140 feet horizontally (figure 3). From these data the depth of the proposed holes was found to average 37.5 feet. An additional 3 feet of drilling below the base of limestone is desirable in order to afford space for any caving that might occur before the hole could be probed with the radiometric logging device. The applicant desired an extra 5 feet of drilling for this purpose but in the case of such relatively shallow holes it would seem that 3 feet would be sufficient. Thus by allowing 3 feet of extra drilling below the base of the limestone the average depth of the holes would be about 40.5 feet.

Based on the foregoing bid of the Four Corners Exploration Co. the estimated cost of the alternative program would be as follows:

Stage	Grid Pattern	Number of Holes	Depth, Feet	Total Feet	Price per Foot	Cost
1	200 feet	48	40.5	1,944	$0.50	$972.00
2	100 feet	123	40.5	4,981.5	0.50	2,490.75
3	50 feet	171	40.5	6,925.5	0.50	3,462.75
	Totals	342		$13,851.0		$6,925.50

Sampling: 342 holes over 20 ft. thickness = 6,840 ft.	@ $0.50	3,420.00
Radiometric logging - 13,851. ft. @ $0.15		2,077.65
All other costs - 13,851 ft. @ $0.15		2,077.65
Total		$14,500.80
Average cost per foot		$1.05

Working continuously 26 days a month with an average footage of 250 feet per day the drilling could be completed in slightly over 2 months.

PROPOSED FINANCING

The project as estimated by the writer would cost $14,500 of which the applicant would furnish 10 percent, or $1,450 and the Government would provide $13,050.

The ore produced from neighboring properties has averaged about $22 a ton. With ore of this value and a 5 pencent royalty the subject property would have to produce about 11,860 tons of ore in order to repay the Government loan. Judged by the information available, the tonnage indicated by the drilling on neighboring properties has averaged about 200 tons of ore per acre. On that basis the 43 acres in question could be expected to yield 8,600 tons of ore. However, because of the unpredictable erratic distribution of the deposits, the subject property could contain more than 8,600 tons, and likewise could contain much less.

CONCLUSIONS AND RECOMMENDATIONS

The productive limestone throughout the area is for the most part completely covered with alluvium or younger sediments so that the only means available for judging the merits of an unexplored tract is its location to known trends and/or its proximity to known ore bodies. The subject property lies within the projected trend of an irregular belt of the Todilto limestone in which ore has been found on neighboring properties and for that reason it is considered worthy of exploration.

The ore-bearing bed underlying the area proposed for exploration is covered with such a thin matte of overburden that any ore found could be mined cheaply in open pits. This would permit the production of uranium from smaller and lower-grade ore bodies than would be economically feasible where a large amount of stripping or underground mining was necessary. Consequently in areas of shallow overburden, such as the tract in question, there is justification for closely spaced drilling in order to discover as many as possible of the smaller, yet profitable ore bodies.

The applicant proposed to award the drilling contract to the Four Corners Exploration Co. This company is a newly formed organization owned jointly by F. O. Manol and Irving Rapaport, both of Grants, N. Mex.

Rapport is a graduate geologist with about 4 years experience in uranium exploration. He was employed about 3 years of that time by the Atomic Energy Commission as project supervisor in Utah and New Mexico. For the past year he has been managing the exploration and mining operations of the Hanosh Mines, Inc. F. O. Manol, the other partner, has been exploiting a uranium property in the Grants district for the past year and a half with considerable success. The equipment belonging to the Four Corners Exploration consisted of a Failing 1500 mobile rotary drilling rig with auxilliary air compressor and Duclone sampler. A truck mounted radiometric hole logging unit had been ordered and delivery was expedted late in October 1953. Whether or not it is available at this time is not known.

As there appears to be a reasonable chance of finding ore on the subject property it is recommended that a loan amounting to $14,500 be approved. A short form contract is suggested specifying a maximum of 13,850 feet of drilling at a price of $1.05 a foot.

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
WASHINGTON 25, D. C.

224 New Customhouse
Denver 2, Colorado

August 16, 1954

Memorandum

To: Secretary to the Operating Committee, DMEA

From: Executive Officer, DMEA Field Team, Region IV

Subject: Docket No. DMEA 3152-Hanosh Mines, Inc., McKinley County New Mexico

Reference is made to our letter to the applicant dated July 16, 1954 in which we gave them thirty days to submit approved Assignment of Lease.

We have not heard from the applicant. Therefore, this docket has been closed.

W. H. King

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
WASHINGTON 25, D. C.

224 New Customhouse
Denver 2, Colorado

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W. H. King

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
WASHINGTON 25, D. C.

224 New Customhouse
Denver 2, Colorado

July 16, 1954.

Mr. George Hanosh, President
Hanosh Mines, Inc.
P. O. Box 338
Grants, New Mexico

Re: Docket No. DMEA-3152

Dear Mr. Hanosh:

We have had no reply to our letter to you dated April 20, 1954 in which we requested the approved assignment of the lease or a photostat of the approved assignment of the lease from D. F. Mollica and George S. Hanosh to Hanosh Mines, Inc.

If we do not receive the approved assignment of the lease within 30 days we will presume that you are no longer interested in the exploration and we will close this docket.

Very truly yours,

W H King

W. H. King
Executive Officer
DMEA Field Team, Region IV

HMC:cwm

cc: Docket
Administrator, DMEA
WMTraver
AHKoschmann
WPWilliams
Chron.

Defense Minerals Administration
RECEIVED
JUL 7 - 1954

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
WASHINGTON 25, D. C.

224 New Customhouse
Denver 2, Colorado

July 1, 1954

Mr. George S. Hanosh, President
Hanosh Mines, Inc.
P. O. Box 338
Grants, New Mexico

Re: DMEA Docket 3152 (Uranium),
Hanosh Mines, Inc., McKinley
County, New Mexico

Dear Mr. Hanosh:

Reference is made to our letter of April 20, 1954, a copy of which is enclosed.

To date, we have not heard from you in regard to the requested assignment of lease.

If we do not hear from you concerning this matter by August 9, 1954, we will consider that you are no longer interested in the Defense Minerals Exploration program and will close your application.

Very truly yours,

W. H. King
Executive Officer
DMEA Field Team
Region IV

Enclosure

RDB:es
cc: Docket 3152
Administrator DMEA
Williams
Traver
Koschmann
Chron.

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
WASHINGTON 25, D. C.

224 New Customhouse
Denver 2, Colorado

April 20, 1954.

Mr. George S. Hanosh, President
Hanosh Mines, Inc.
P. O. Box 338
Grants, New Mexico

Re: Docket No. DMEA-3152

Dear Mr. Hanosh:

This replies to your letter of April 16, 1954 informing us that D. F. Mollica and George Hanosh are the sole owners of Hanosh Mines, Incorporated.

The mining lease on allotted Indian lands, which is the subject of your Defense Minerals Exploration Administration application, was issued to two individuals, George S. Hanosh and D. F. Mollica. The DMEA application for exploration assistance was made in the name of Hanosh Mines, Inc., a New Mexico corporation.

If the exploration project contract is to be awarded to Hanosh Mines, Inc., George S. Hanosh and D. F. Mollica must assign the lease made to them, as individuals, to Hanosh Mines, Inc.

Please refer to paragraph 3(g) of your mining lease which specifies - "Not to assign this lease or any interest therein by an operating agreement or otherwise, nor to sublet any portion of the leased premises before restrictions are removed, except with the approval of the Secretary of the Interior."

Before we can process the contract we must have the approved assignment of the lease or a photostat of the approved assignment of the lease from D. F. Mollica and George S. Hanosh to Hanosh Mines, Inc.

Very truly yours,

John F. Shaw

John F. Shaw
For W. H. King
Executive Officer
DMEA Field Team, Region IV

HMC:cwm

cc: Docket
Administrator, DMEA
WMTraver
AHKoschmann
RPFischer
Chron.
HMConnors

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
WASHINGTON 25, D. C.

224 New Customhouse
Denver 2, Colorado

March 19, 1954

Mr. George Hanosh, President
Hanosh Mines, Inc.
P.O. Box 338
Grants, New Mexico

Re: Docket DMEA 3152

Dear Mr. Hanosh:

The mining lease on the NE¼ Sec. 22, T. 13 N., R. 10 W., was issued to George Hanosh and D.F. Mollica as individuals. The DMEA application was made in the name of Hanosh Mines, Inc., a New Mexico corporation.

Paragraph 3(g) of the lease specifies "Not to assign this lease or any interest therein by an operating agreement or otherwise, nor to sublet any portion of the leased premises before restrictions are removed, except with the approval of the Secretary of the Interior."

If the Exploration Project Contract is to be awarded to Hanosh Mines, Inc. as operator please furnish this office with the approved assignment of the lease from George Hanosh and D.F. Mollica to Hanosh Mines, Inc.

When we receive the approved assignment of the lease or a photostat of the approved assignment of the lease we will continue to process the contract.

Very truly yours,

W. H. KING

W. H. King
Executive Officer, DMEA
Field Team, Region IV

HMC:jp
cc Subject
Chron
COMittendorf
WMTraver
RPFischer
AHKoschmann
HMConnors

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
WASHINGTON 25, D. C.

224 New Customhouse
Denver 2, Colorado

March 3, 1954.

Memorandum

To: Administrator, Defense Minerals Exploration Administration
Attention: 200

From: Field Team, Region IV

Subject: Report of Examination - DMEA Docket 3152 (Uranium), Hanosh Mines, Inc., McKinley County, New Mexico.

Exploration assistance in the amount of $13,851.00 has been approved and a contract will be prepared by this office.

Four copies of the report of examination will be forwarded you when the contract is executed.

The original and one copy of Form 3b are attached.

W. H. King

W. H. King

A. H. Koschmann

A. H. Koschmann

Enclosures

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
WASHINGTON 25, D. C.

224 New Customhouse
Denver 2, Colorado

March 3, 1954.

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W. H. King
W. H. King

A. H. Koschmann
A. H. Koschmann

Enclosures

DMEA Form 3b
(Revised)

DEFENSE MINERALS EXPLORATION ADMINISTRATION

CONTROLLED DOCUMENT
Revised Abstract

DMEA Docket No. 3152

Name of Applicant Hanosh Mines, Inc.

Change:	From		To		
	III 1	[ ]	III 1	[x]	2-26-52
	III 2	[ ]	III 2	[ ]	
	III 3	[ ]	III 3	[ ]	
	III 4	[x]	III 4	[ ]	
	III 5	[ ]	III 5	[ ]	
			III 6	[ ]	
			III 7	[ ]	

Add:

II 7 $ 26,460.69

II 8 $ 13,851.00

II 8a %

II 9 $

Remarks:

Initials of person preparing sheet H.M.C.

Date sheet prepared 2-26-52

33978

DMEA Form 3b
(Revised)

DEFENSE MINERALS EXPLORATION ADMINISTRATION

CONTROLLED DOCUMENT
Revised Abstract

DMEA Docket No. 3152

Name of Applicant Hanosh Mines, Inc.

Change:	From		To	
	III 1	[ ]	III 1	[x] 2-26-52
	III 2	[ ]	III 2	[ ]
	III 3	[ ]	III 3	[ ]
	III 4	[x]	III 4	[ ]
	III 5	[ ]	III 5	[ ]
			III 6	[ ]
			III 7	[ ]

Add:

II 7 $ 26,460.69

II 8 $ 13,851.00

II 8a % _____

II 9 $ _____

Remarks:

Initials of person preparing sheet H.M.C.

Date sheet prepared 2-26-52

33978

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
WASHINGTON 25, D. C.

224 New Customhouse
Denver 2, Colorado

February 26, 1954.

DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
RECEIVED
MAR 1 - 1954

Hanosh Mines, Inc.
Box 447
Grants, New Mexico

Re: Docket No. DMEA-3152

Gentlemen:

In preparing a contract for exploration work on your property it will be necessary for us to know in which state Hanosh Mines is incorporated. We will also require a signed copy of your lease or a photostat of a signed copy of the lease.

When this information is received by this office, we will be pleased to continue to process the contract.

Very truly yours,

W. H. King
Executive Officer
DMEA Field Team, Region IV

HMC:cwm

cc: Docket
Administrator, DMEA
WRStorms
AHKoschmann
Chron.
HMConnors

MF-103
(Revised April 1952)

UNITED STATES DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION

Form Approved.
Budget Bureau No. 42-R1035.2.

APPLICATION FOR AID IN AN EXPLORATION PROJECT, PURSUANT TO DMEA ORDER 1, UNDER THE DEFENSE PRODUCTION ACT OF 1950, AS AMENDED

Not to be filled in by applicant

Docket No. DMEA-3152
Metal or Mineral
Date Received 8/31/53
Estimated Cost
Participation (Government %)

INSTRUCTIONS

1. *Name of applicant.*—(*a*) State here your full legal name, in the form in which you will wish to contract, and your mailing address: Kenosh Mines, Incorporated. Box 447, Grants, New Mexico.

(*b*) If other than an individual, add to your name above whether a corporation, partnership, etc., and the name of the State in which incorporated or otherwise organized.

(*c*) If a corporation, add to above statement, titles, names and addresses of officers.

(*d*) If a partnership, add to the above statement the names and addresses of all partners.

2. *General.*—Read DMEA Order 1, "Government Aid in Defense Exploration Projects," before completing this application. Submit this application and all accompanying papers in quadruplicate (four copies), with your name and address on each sheet of the application and on all accompanying papers. Where sufficient space is not provided on the form for all required information, state it on an accompanying paper, with a reference in each case to the instruction to which it refers by number. Comply with all applicable instructions; or, if not applicable, so state. File the application with Defense Minerals Exploration Administration, Department of the Interior, Washington 25, D. C., or with the nearest field executive officer thereof.

3. *Applicant's property rights.*—(*a*) State the legal description of the land upon which you wish to explore, including all land which you possess or control that may be benefited by the exploration, and excluding any land or interest in land which is not to be included in the exploration project contract Northeast 1/4, Section 28, Township 13 North, Range 10 West, McKinley County, New Mexico.

(*b*) State any mine name by which the property is known. none

(*c*) State your interest in the land, whether owner, lessee, purchaser under contract, or otherwise The property is an Indian allotment held under lease by Kenosh Mines, Inc.

(*d*) If you are not the owner, submit with this application a copy of the lease, contract, or other document under which you control the property.

(*e*) If you own the land, describe any liens or encumbrances on it

(*f*) If the land consists of unpatented claims, add to the description above, the book and page numbers for each recorded location notice.

4. *Physical description.*—(*a*) Describe in detail any mining or exploration operations which have been or now are being conducted upon the land, including existing mine workings and production facilities. State your interest, if any, in such operations. Also describe accessibility of mine workings for examination purposes.

(*b*) State past and current production, and ore reserves, if any, giving quantities and grades.

(*c*) Describe the geologic features of the property, including mineralization, type of deposit (vein, bedded, etc.), and your reasons for wishing to explore. Illustrate with maps or sketches. Send with your application (but not necessarily as a part of it) any geologic or engineering report, assay maps, or other technologic information you may have, indicating on each whether you require its return to you.

(*d*) State the facts with respect to the accessibility of the project: Access roads, distances to shipping, supply and residence points.

(*e*) State the availability of manpower, materials, supplies, equipment, water, and power.

5. *The exploration project.*—(*a*) State the [illegible]neral or minerals for which you wish to explo[illegible]ranium

(*b*) Describe fully the proposed work, including a map or sketch of the property showing a plan (and cross sections if needed) of any present mine workings, and the location of the proposed exploration work as related to such features as contacts, veins, ore-bearing beds, etc.

(*c*) The work will start within 30 days and be completed within 3 months from the date of an exploration project contract.

(*d*) State the operating experience and background of the applicant with relation to the ability to carry out such exploration project, and also that of the person or persons who will supervise the operations.

6. *Estimate of costs.*—Furnish a detailed estimate of the costs of the proposed work (you will have to use a separate sheet), under the following headings. Add the totals under all headings to give the estimated total cost of the project:

(*a*) *Independent contracts.*—(Note.—If the applicant does not intend to let any of the work to contractors, write "none" after this item. To the extent that the work is to be contracted, do not repeat the cost of the contract-work in subsequent items.) State the cost of any proposed independent contracts for the performance of all or any part of the work, expressed in terms of units of work (such as per foot of drilling, per foot of drifting, per hour of bulldozer operations, per cubic yard of material moved, etc.).

(*b*) *Labor, supervision, consultants.*—Include an itemized schedule of numbers, classes and rates of wages, salaries or fees for necessary labor, supervision and engineering and geological consultants.

(*c*) *Operating materials and supplies.*—Furnish an itemized list, including items of equipment costing less than $50 each, and power, water and fuel.

(*d*) *Operating equipment.*—Furnish an itemized list of any operating equipment to be rented, purchased, or which is owned and will be furnished by the Operator, with the estimated rental, purchase price, or suggested use-allowance based on present value, as the case may be.

(*e*) *Rehabilitation and repairs.*—Furnish a detailed list showing the cost of any necessary initial rehabilitation or repairs of existing buildings, installations, fixtures, and movable operating equipment, now owned by the Operator and which will be devoted to the exploration project.

(*f*) *New buildings, improvements, installations.*—Furnish a detailed list showing the cost of any necessary buildings, fixed improvements, or installations to be purchased, installed or constructed for the benefit of the exploration project.

(*g*) *Miscellaneous.*—Furnish a detailed list showing the cost of repairs to and maintenance of operating equipment (not including initial rehabilitation or repairs of the Operator's equipment), analytical work, accounting, workmen's compensation and employers' liability insurance, and payroll taxes.

(*h*) *Contingencies.*—Give an estimate of any necessary allowances for contingencies not included in the costs stated above.

NOTE.—No items of general overhead, corporate management, interest, taxes (other than payroll and sales taxes), or any other indirect costs, or work performed or costs incurred before the date of the contract, should be included in the estimate of costs.

7. (*a*) Are you prepared to furnish your share of the cost of the proposed project in accordance with the regulations on Government participation (Sec. 7, DMEA No. 1)?

(*b*) How do you propose to furnish your share of the costs?

/ ☐ Money ☐ Use of equipment owned by you ☐ Other

Explain in detail on acompanying paper.

CERTIFICATION

The undersigned, whether as an individual, corporate officer, partner, or otherwise, both in his own behalf and acting for the applicant, certifies that the information set forth in this form and accompanying papers is correct and complete, to the best of his knowledge and belief.

Dated August 8, 195[illegible]

Hanosh & Mollica
(Applicant)

By George S Hanosh

Title 18, U. S. Code (Crimes), Section 1001, makes it a criminal offense to make a willfully false statement or representation to any department or agency of the United States as to any matter within its jurisdiction.

U. S. GOVERNMENT PRINTING OFFICE 16—66551-1

1. b) Incorporated in New Mexico

c) President --- George S. Hanosh, Box 447, Grants, N.M.
Treasurer --- Annabelle Hanosh, Box 447, Grants, N.M.
Secretary --- D. F. Mollica, Gallup, N.M.

4. a) This property, in McKinley County, New Mexico, may be reached in the following manner: 1) Travel three miles west on U.S. #66 from the town of Grants; 2) Turn north on U.S. #53 (the San Mateo Road) and go eleven miles along the valley floor. This road then ascends a gently sloping portion of the Entrada Sandstone scarp for approximately a mile and descends upon the broad Todilto Limestone bench: 3) Turn northwest at a well constructed cattle-guardand follow the most prominent graded road past numerous open pit and underground uranium operations for approximately four miles.

It has taken the Indian Service approximately two years to sign this lease. Therefore, only geologic mapping and sampling and no physical development has been completed.

b) No production.

c) Geologic Reasons for Wishing to Explore the N.E. ¼ of Sect. 22.

1) Favorable Location

Virtually all of the large mines and blocked out ore bodies of the Grants District are situated between Haystack Butte and Grants Mesa, a distance of about 13 miles. (fig. 1) The extension of this apparent mineral belt for fourty miles to the northwest, contains scattered prospects. No major deposits have been developed in this direction. Southeast of Grants Mesa, for approximately fourty miles, numerous uranium showings have also been discovered. With the exception of the Jackpile Mine of Anaconda, no appreciable tonnage has been developed. The property for which application is asked is situated in the central portion of the main productive area. It lies squarely across the apparent mineral belt. The only adjacent property which has been explored, Santa Fe's Section23, contains about 30,000 tons of uranium ore.

2) Ease of Exploration

The two major ore horizons in this district are the Todilto limestone and the Morrison formation. The Morrison formation is assuming greater economic importance, but the bulk of developed ore lies within the Todilto limestone.

One of the major reasons for the rapid development of the Grants District is the ease with which the Todilto limestone may be explored. The limestone is the most resistant rock in the Jurassic section and forms a gently dipping bench (4°) under shallow cover for as much as a half mile back from the Entrada sandstone rim. This feature is well demonstrated by the fact that the deepest hole proposed on this property, 1700 feet back from the rim, has but 49 feet overburden to penetrate. The 43 feet average depth of hole consists of 18 feet of overburden, 20 feet of limestone, and 5 feet of underlying sandstone. More of the ore horizon is examined per dollar of exploration than any other area of carnotite-type deposits.

3) High-grade ore

The uranium minerals of the blanket-type ore deposits initially mined in Todilto limestone, on or close to the rim, consisted of carnotite, tyuyamunite, and uranophane, with limonite, hematite, and coarsely-crystalline calcite. At depth, away from the rim, the above oxide-type minerals are in lesser amount and larger amounts of pitchblende, fluorite, barite, and pyrite are discernable. Two showings of carnotite are present along the rim of Section22 and an ore-grade prospect is situated in an arroyo near the north line of this section. (fig. 2)

d) Section 22 is 22 miles by road from the Anaconda Copper Mining Co. mill at Bluewater, New Mexico. Fifteen miles of improved and maintained road lead from the property to the main line of the Santa Fe Railway and U.S. #66. It is 7 miles on U.S. #66 to the mill from this point. The town of Grants is 13 miles from this property.

e) An abundant supply of cheap labor is available in this area. The Navajo Indians are excellent for mucking and hand sorting. The shut-down of the fluorite mines in this area has provided a surplus of skilled miners. Powder, hardware, timber, and truck parts are available at Grants. Inexpensive fuel can be obtained at the Prewitt oil refinery close to the mill site. Almost all mining machinery firms maintain dealerships at Albuquerque, 80 miles east of Grants over U.S. #66. A water well is present on Section 22.

5. b) Figure 2 illustrates the desired work. It is proposed that an initial 100 foot grid of 207 holes, averaging 45.08 feet in depth, be completed first. The disposition of holes on 50 and 25 foot centers shall be determined by the results obtained by the initial grid. Approximately 20% of the holes drilled in the central portion of the Grants District have shown gamma ray counts about three times that of the background count of the hole. Applying this ratio, (see fig. 3), 285.66 offset holes on 50 foot centers are anticipated. Ten percent of the holes on 50 foot centers contained .05% U_3O_8 or better. On this basis, 213.25 holes on 25 foot centers are anticipated. Several of the mine owners in this district prefer to continue their search for ore on 10 foot centers. It is our opinion that the large additional expense is not warranted by the small pods of uranium found in this manner. (For summary of proposed drilling see Table 1.)

It is proposed that reliance be placed on radiometric logging for holes on 100 and 50 foot centers. (see sheet on the value of radiometric logging.) ~~The A.E.C. has a logging truck in this area and has volunteered to perform the service without charge~~. The cuttings from the 20 feet of limestone in holes on 25 foot centers shall be collected at two foot intervals and the portions of these cuttings which show abnormal radioactivity shall be radiometrically assayed. To definitely check the uranium values obtained by probing and radiometric assaying, twenty random chemical assays shall be run on cuttings.

d) It is proposed that the Four Corners Exploration Company, of Grants, New Mexico, undertake all drilling, geologic work, surveying, accounting, and supervision involved in this program. Mr Irving Rapaport, co-owner of the Four Corners Exploration Co. and the proposed supervisor of this program has had the following experience.

Chronologically:

Miner - Evergreen Mining Company, Colorado, Minn.	3 months
" - Climax Molybdenum Co., Climax, Colo.	9 "
" - Golden Cycle Corp., Cripple Creek, Colo.	1 "
" - Sunshine Mining Co., Wallace, Idaho	3 "
Bachelors in Geologic Engineering, U. of Minnesota	1949
Geologist A.E.C. Exploration Projects	
Calamity Mesa, Colo.	9 "
Project Supervisor A.E.C. Exploration Projects	
Marysvale, Utah	9 "
Grants, New Mexico	15 "
Manager, Manoah Mines, Inc.	15 "
Consultant Geologist	Total of
Chilean Nitrate Corporation	110 days at
J.H. Whitney Enterprises	$100.00 per
Spencer Chemical Co.	day

6. a) It is proposed that all drilling to done by a Failing 1,500 rotary rig at the rate of $.50 per foot by the Four Corners Exploration Company. The approximate cost of previous exploration cost in this area is:

Type	Company	Cost
Core drilling	Anaconda	$2.15 per foot
Wagon drilling	Santa Fe R.R.	$.90 " "
" "	Anaconda	$.90 " "
" "	Manoah Mines, Inc.	$.95 " "
" "	Manol and partners	$1.05 " "

The A.E.C. has let a contract to the low bidder for rotary drilling in this area at $.575 per foot. The previous low unit cost for A.E.C. exploratory drilling was the wagon drilling contract at Temple Mountain, Utah, at $.98 per foot.

For that minor proportion of the drilling where sample is desired a cost of $1.60 per foot is bid.

An additional cost of $.15 per foot has been added to cover the cost of geologic work, radiometric assays of the cuttings, 20 check chemical assays, surveying, accounting, correspondence, and supervision. (For tabulation of drilling, see Table 1).

The A.E.C. has stated that its radiometric logging truck is to be used primarily for its own drilling, and may not be available for private exploration. A truck-mounted radiometric logging unit, somewhat inferior to that employed by the A.E.C. is to be bought for use on this program. An additional $.15 per foot is proposed for this service.

b), c), d), e), f), g), and h).

The individual items of expense are not listed as a per unit basis is being employed in this bid.

The equipment to be used on this job includes:

Item	Approximate Cost New
1 Failing rotary drilling rig (1,500' rated capacity)	$27,000.00
1 Ingersol Rand Gyroflow Compressor (315 c.f.m.)	3,200.00
1 S.D. Duclono sampler	500.00
1 Chevrolet truck for compressor (1½ ton)	3,200.00
2 Pickup trucks (½ ton)	3,300.00
1 Truck-mounted radiometric logging unit	3,500.00
Total	$45,700.00

7. a) Henosh Mines, Inc. is fully prepared to furnish its share of the cost of the proposed project in accordance with the regulations on Government participation.

b) Henosh Mines, Inc. share of the expense of exploration will be provided in money.

Table 1

SUMMARY OF DRILLING

SECTION 22, T 13 N, R 10 W.

Phase	No. Holes	Avg. Depth	Total Feet	Cost/Ft.	Total Cost
Initial Grid (100')	207	43.08*	8,919	$.50	$4,459.00
Secondary Grid (50')**	285.66	43.08	12,305.43	$.50	$6,152.715
Tertiary Grid (25')***	213.25	43.08			
a) Limestone Cuttings required		20.00	4,265.00	$1.00	$4,265.00
b) Overburden		23.08	4,921.81	$.50	$2,460.905
Totals	705.91	43.08	30,410.24	$.570	$17,337.620

Radiometric logging and the preparation of a permanent geologic record of every hole ---------- 30,410.24' @ $.15/Ft-$4,561.536

Supervision, accounting, correspondence, surveying, collection of cuttings, twenty chemical assays of cuttings, radiometric assays of cuttings, geologic mapping, and ore reserve calculations. 30,410.24' @ $.15/Ft-$4,561.536

Total maximum cost of exploration program $26,460.692

* Average hole is composed of:
18.08 feet of overburden (alluvium, siltstone, and shale)
20.00 " " limestone (ore horizon)
5.00 " " sandstone (underlying Entrada sandstone)

** The ratio developed in figure 3, assuming 20% of holes on the initial grid to be mineralized, was applied to yield a total of 285.66 holes on the secondary grid.

*** The ratio developed in figure 3, assuming 10% of holes on the secondary grid to yield sharp anomalies, was applied to obtain the figure of 213.25 holes on the tertiary grid.

[illegible]
[illegible] 101
[illegible]

[illegible]

1) An exact, constant, and permanent record of the intensity of gamma radiation of every inch of the hole is produced.

2) The extreme sensitivity of this machine presents two major advantages.

a) Each trace may be differentiated by their relative inherent radioactivity. Specifically, the driller is often unable to distinguish slightly consolidated overburden from the Jumperville formation silty mudstones. Overburden can be carbonated without bacting at approximately [illegible] per yard. The Jumperville must be shot and removed at a cost of approximately [illegible] per [illegible].

b) A large hole of trace mineralization [illegible] are bodies. The hole may consist of but a few crystals of [illegible] mineral along a bedding plane. This amount of [illegible] produces a [illegible] when the hole is [illegible]. These important traces are not discernable when diluted by more than 25 inches of barren cuttings.

3) The exact thickness of ore is defined.

4) The [illegible] is able to decide where to drill off-[illegible] holes immediately.

5) The overall cost of exploration is reduced.

a) The volume of cuttings handled by the laboratory is reduced.

b) Radioactive [illegible] eliminates most of the expense of catching cuttings.

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS
EXPLORATION ADMINISTRATION
WASHINGTON 25, D. C.

OFFICIAL BUSINESS

PENALTY FOR PRIVATE USE TO AVOID
PAYMENT OF POSTAGE, $300
(PMGC)

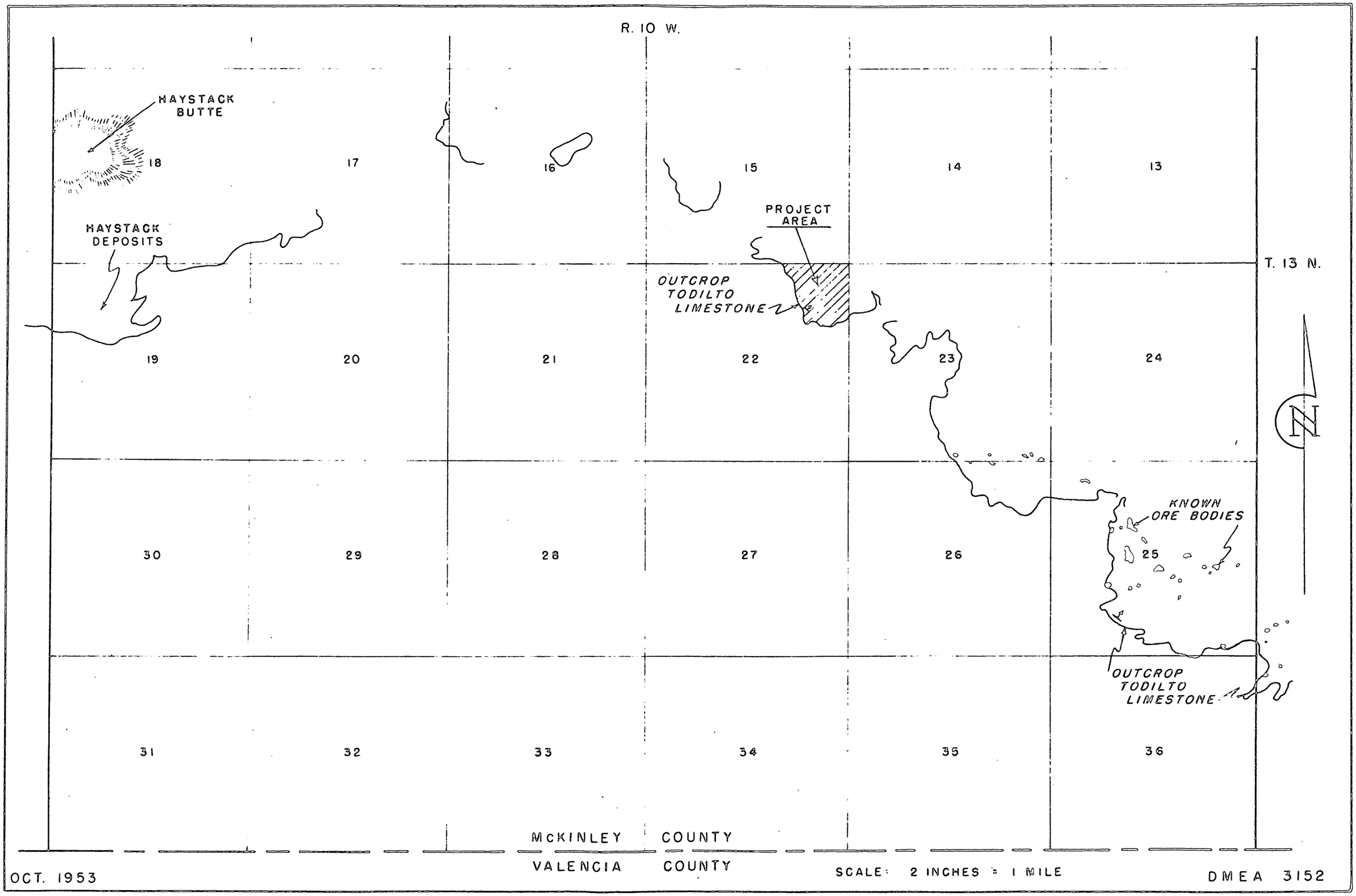


FIGURE 2. - OUTCROPS OF TODILTO LIMESTONE
(SHOWING SOME OF THE KNOWN ORE BODIES)

HANOSH MINES, INC. McKINLEY COUNTY, NEW MEXICO

The area proposed for exploration covers about 43 acres situated in the extreme northeast corner of Sec. 22. The land in Secs. 15 and 23, which immediately adjoins the subject property on the north and east, is either owned or controlled by the Atchison, Topeka & Santa Fe Railway Co. (figure 3). The applicant company is producing ore from another lease covering a portion of Sec. 26, T. 13 N., R. 10 W.

DESCRIPTION OF THE DEPOSITS

Uranium mineralization in the area under consideration occurs in the Todilto limestone. This formation is a persistent gently-dipping bed averaging about 20 feet in thickness. The tract proposed for exploration is underlain by this limestone. Its irregular outcrop marks the western and southern boundaries of the project area (fig. 3). Erosion has completely removed the Todilto limestone from all of Sec. 22 with the exception of the extreme northeastern corner which constitutes the area proposed for exploration. Except in the immediate vicinity of the outcrop the favorable bed is usually completely concealed by varying thicknesses of overburden. This is not only true of the tract under consideration but prevails generally throughout the district. Although showings of uranium mineralization are not uncommon along the outcrop of the Todilto it appears that very few of the district's more important ore bodies have been found exposed in this manner. Closely spaced blind drilling has been the chief means of finding and outlining the present ore reserves of the district.

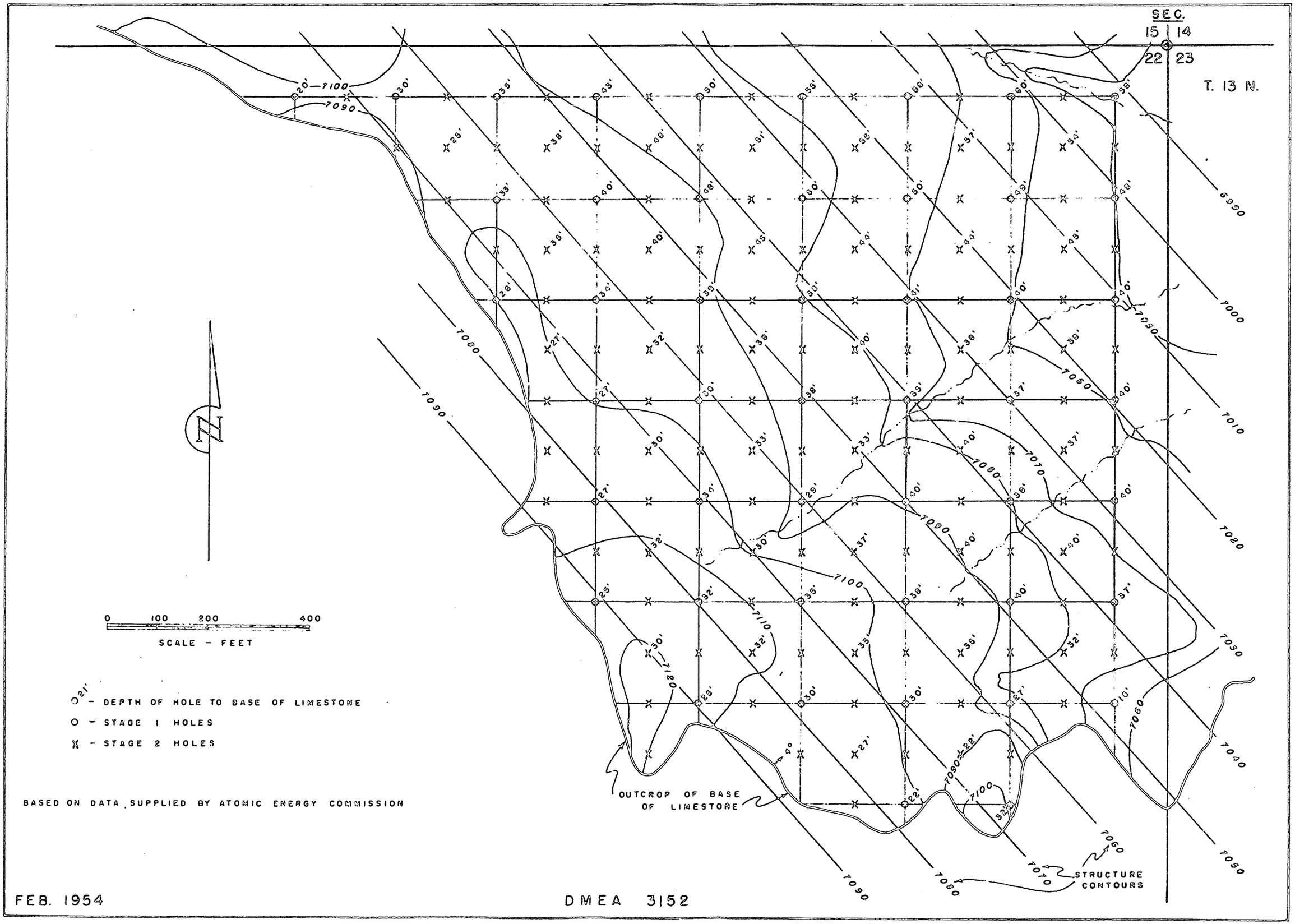


FIGURE 3. - TOPOGRAPHIC AND STRUCTURAL CONTOUR MAP

HANOSH MINES, INC. (SHOWING STAGE 1 AND 2 OF PROPOSED DRILLING) McKINLEY COUNTY, NEW MEXICO

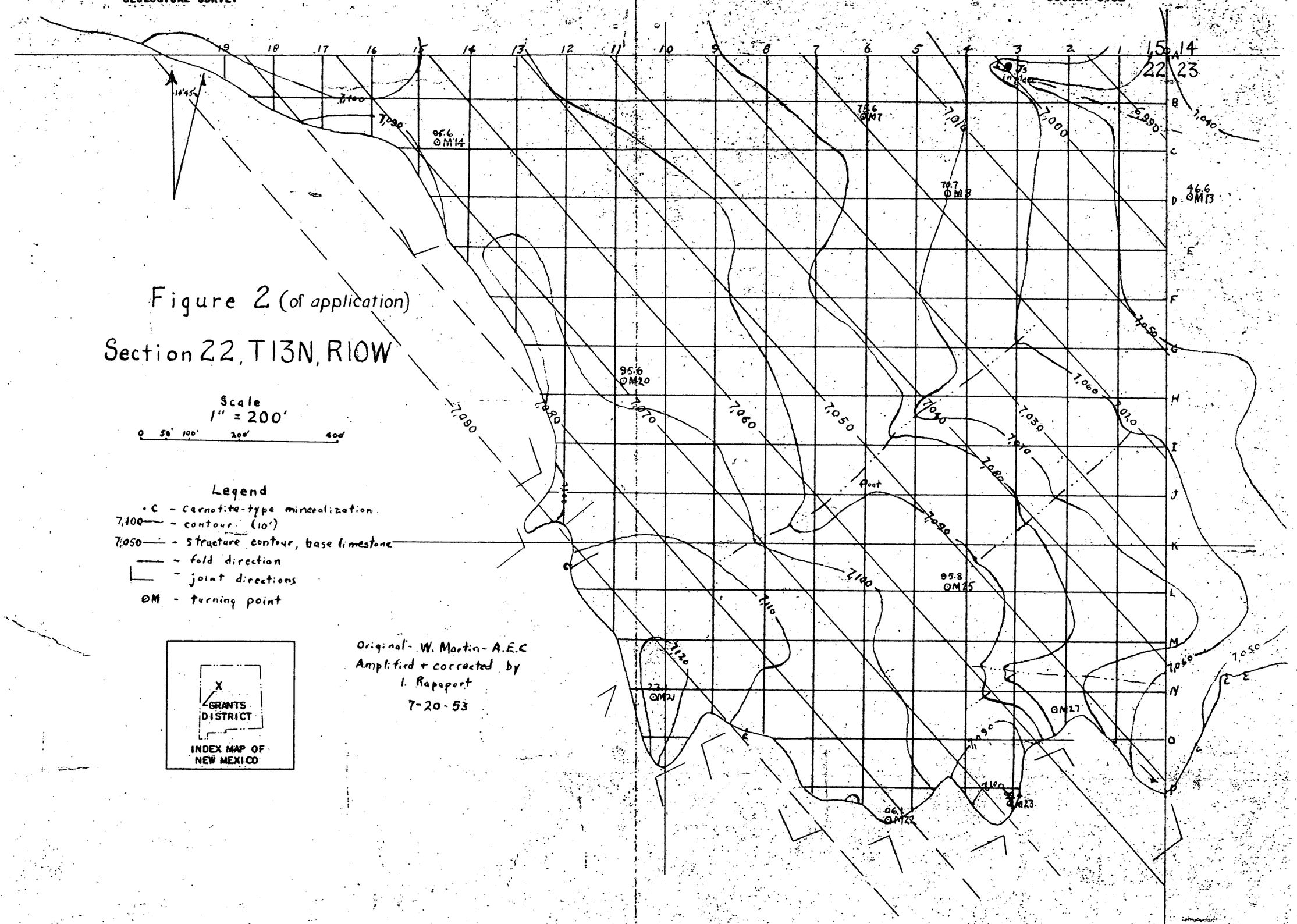
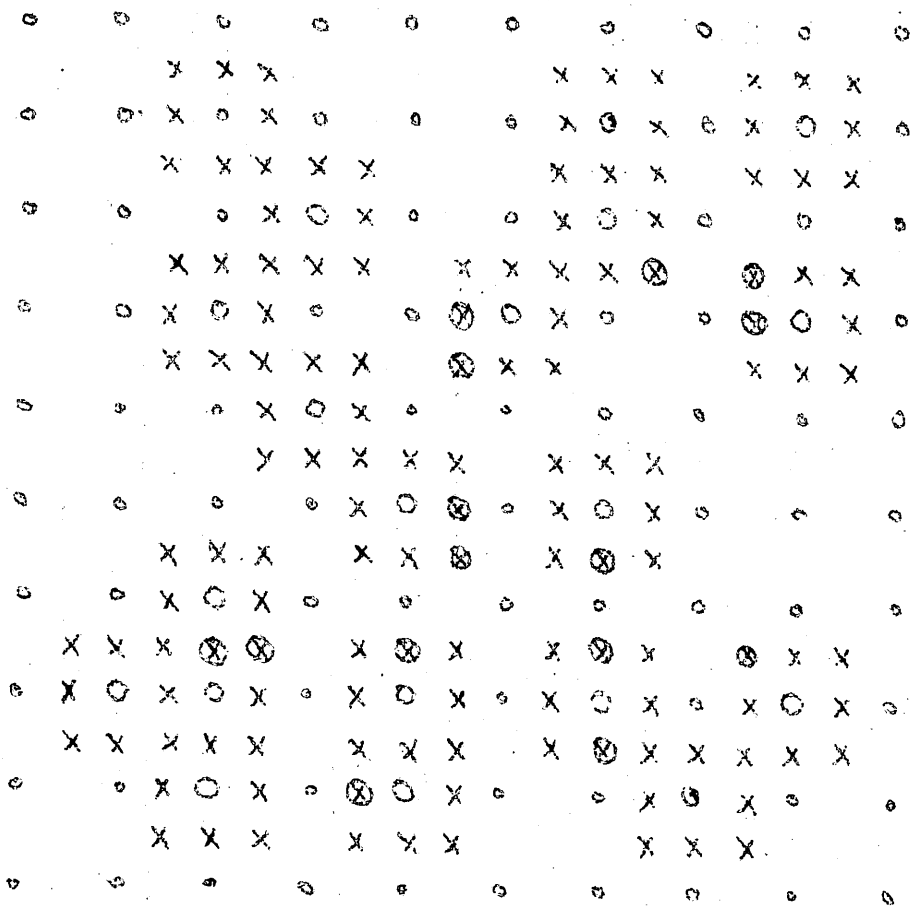


Figure 1. INITIAL DRILLING PATTERN, SUGGESTED BY APPLICANT, KANOSH MINES INC., GRANTS DISTRICT, McKINLEY COUNTY, NEW MEXICO

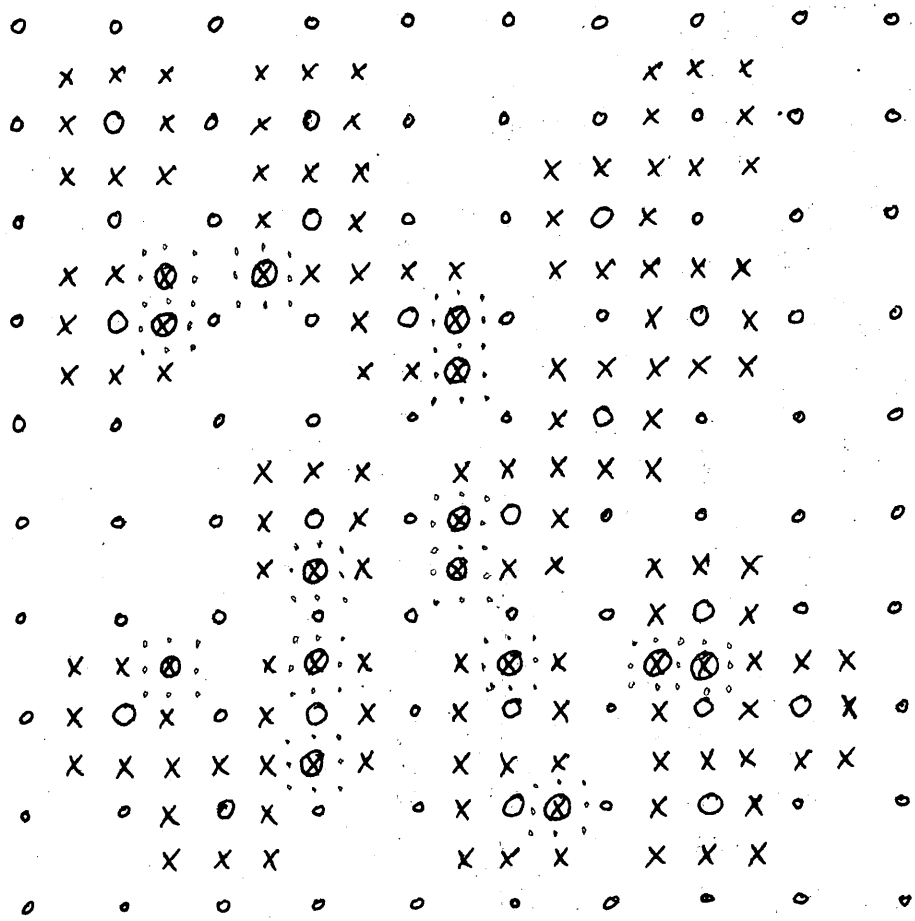
Figure 3



1) o 100 holes initial (10c) grid
○ 20% (20) " mineralized (3X background)
2) X 138 " secondary (50') grid required
⊗ 10% (10.8) " mineralized (approaching ore grade) (1.50 oz/t = .04% V_3O_8)
3) 103 " tertiary (25') grid required

1. Rapport
8-6-53

Figure 3



DMEG-3152

1) o 100 holes initial (100') grid
O 20% (20) " mineralized (3X background)
2) X 138 " secondary (50') grid required
⊗ 10% (13.8) " mineralized (approaching ore grade) (1,500 c/s = .04% U_3O_8)
3) · 103 " tertiary (25') grid required

I. Rapaport
8-6-53

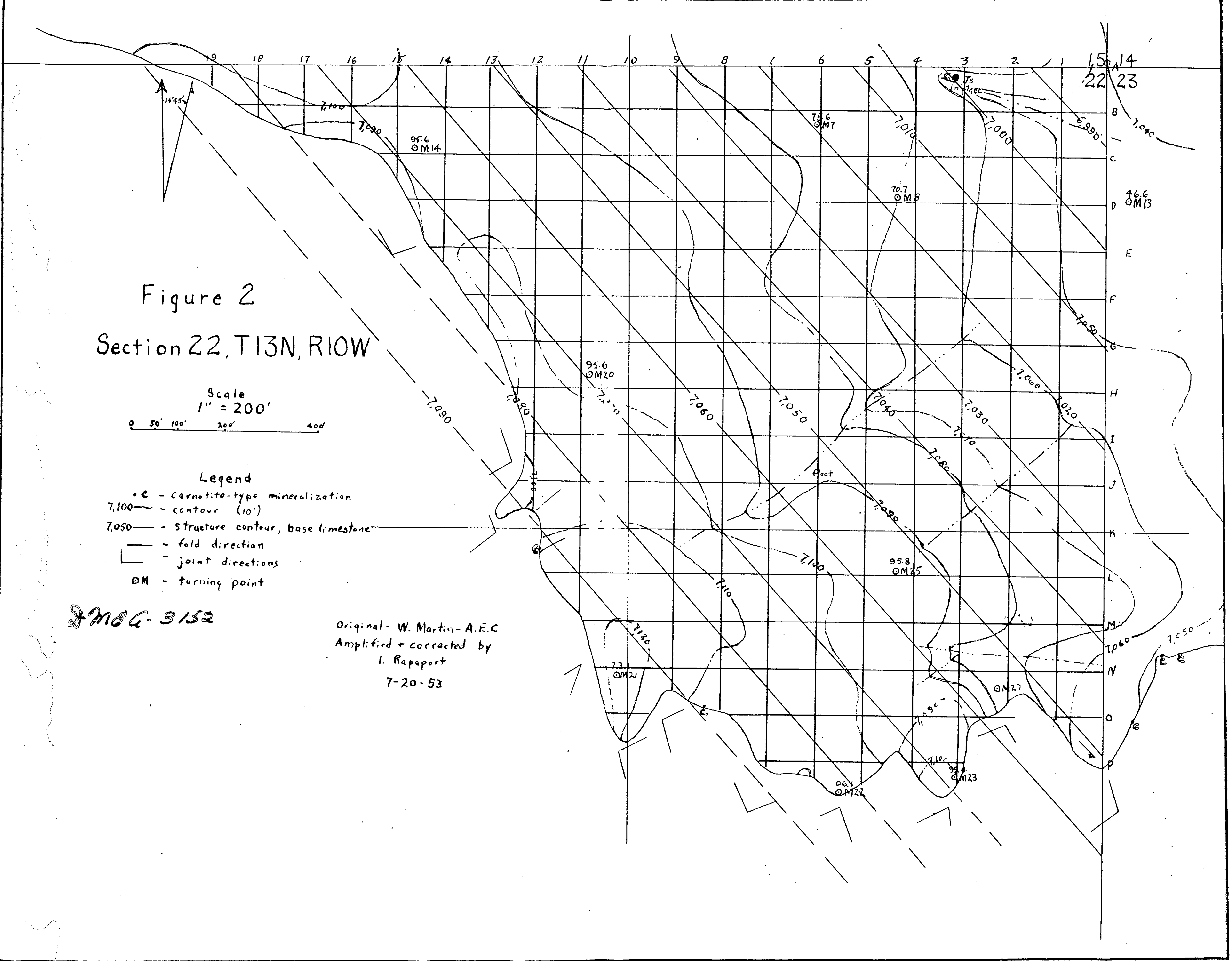


Figure 2
Section 22, T13N, R10W
Scale
1" = 200'
0 50' 100' 200' 400'
Legend
• c - Carnotite-type mineralization
7,100 - contour (10')
7,050 - Structure contour, base limestone
- fold direction
- joint directions
OM - turning point
JM&G-3152
Original - W. Martin - A.E.C
Amplified + corrected by
I. Rapaport
7-20-53
19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
15 14
22 23
A B C D E F G H I J K L M N O P
95.6 OM14
75.6 OM7
70.7 OM8
46.6 OM13
95.6 OM20
95.8 OM25
OM27
OM23
OM22
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7,100
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7,080
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6,990
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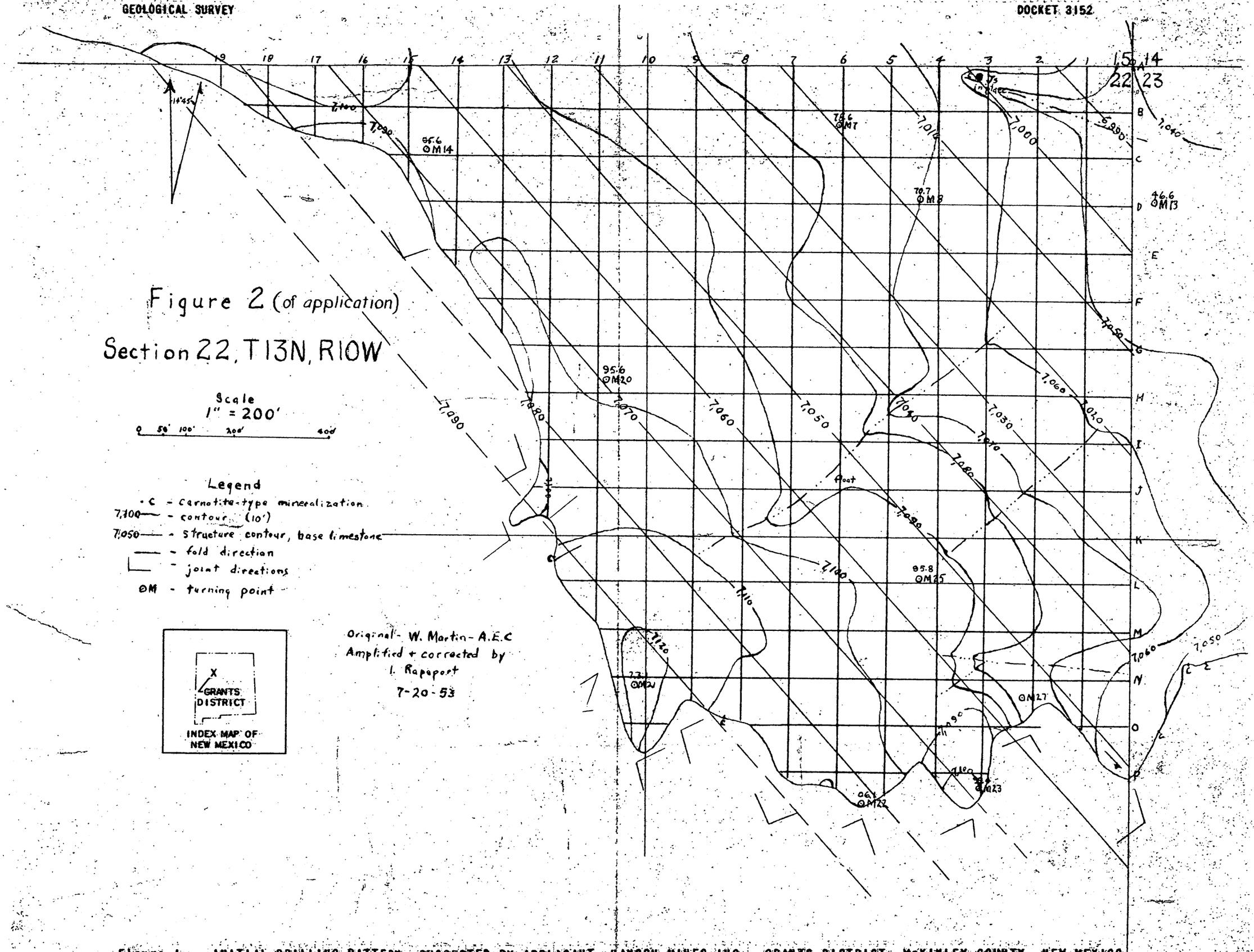

Figure 1. INITIAL DRILLING PATTERN, SUGGESTED BY APPLICANT, HANOSH MINES INC., GRANTS DISTRICT, McKINLEY COUNTY, NEW MEXICO

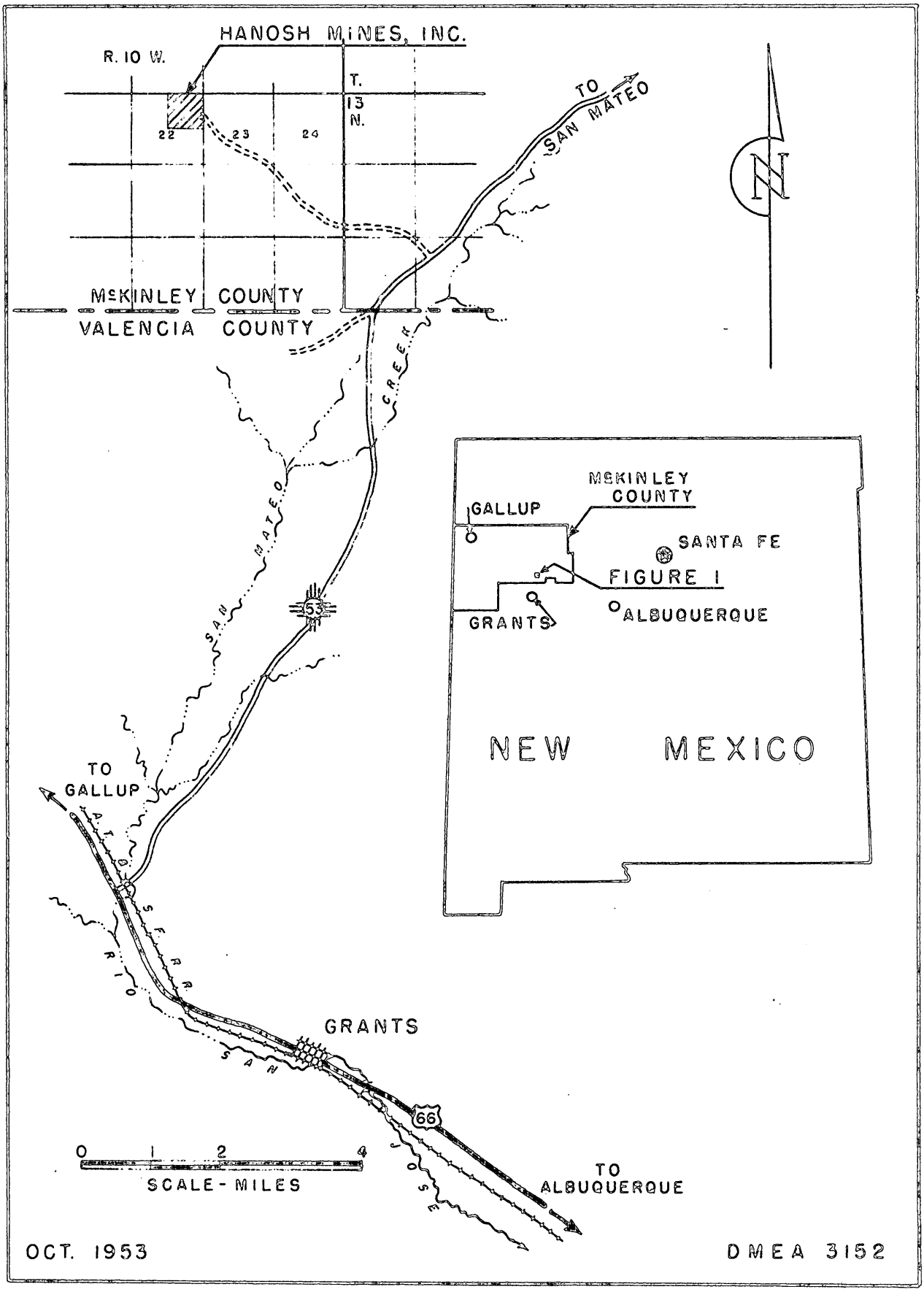

FIGURE 1, - LOCATION MAP - HANOSH MINES, INC.
McKINLEY COUNTY, NEW MEXICO

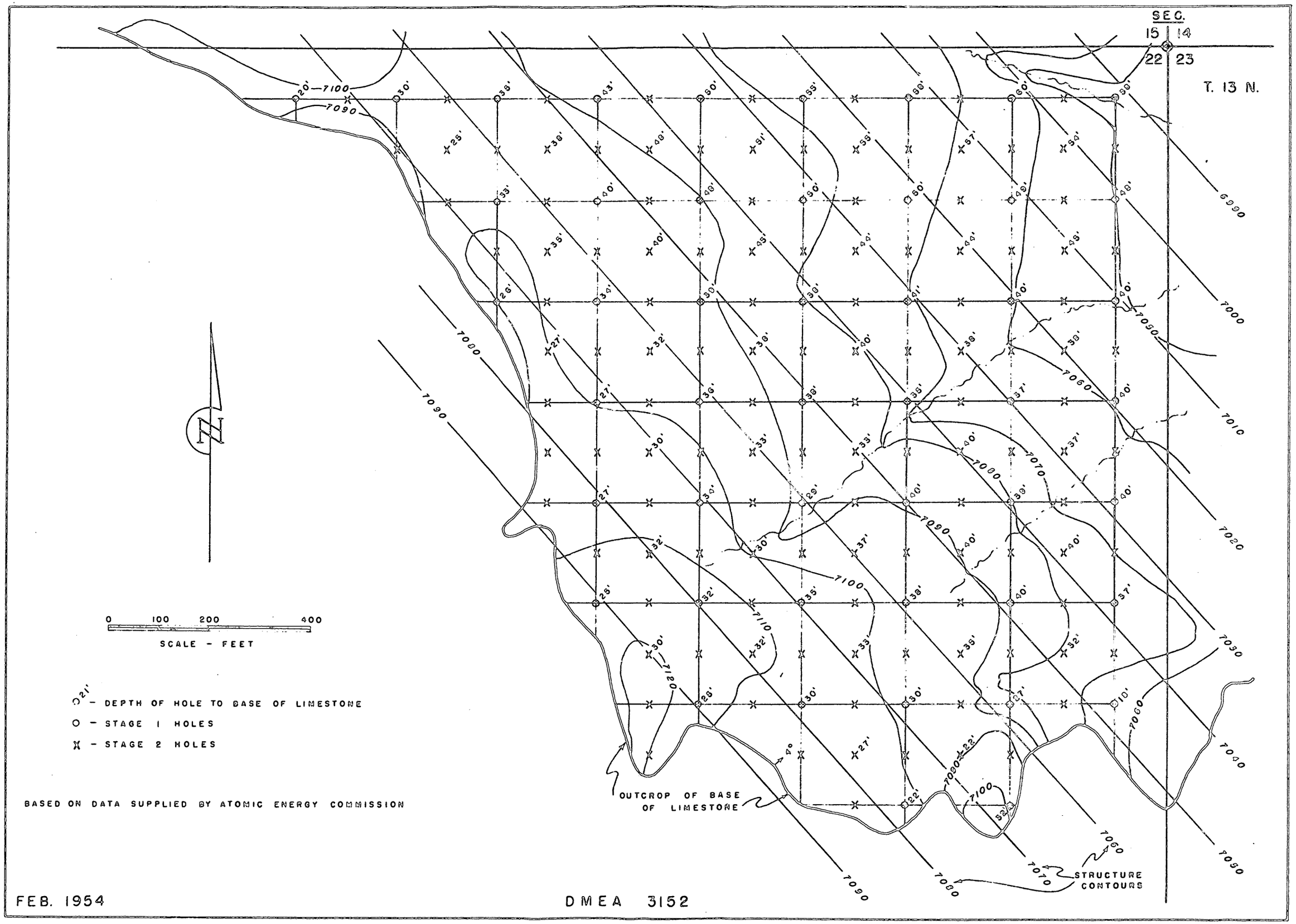

FIGURE 3. - TOPOGRAPHIC AND STRUCTURAL CONTOUR MAP

HANOSH MINES, INC. (SHOWING STAGE 1 AND 2 OF PROPOSED DRILLING) McKINLEY COUNTY, NEW MEXICO

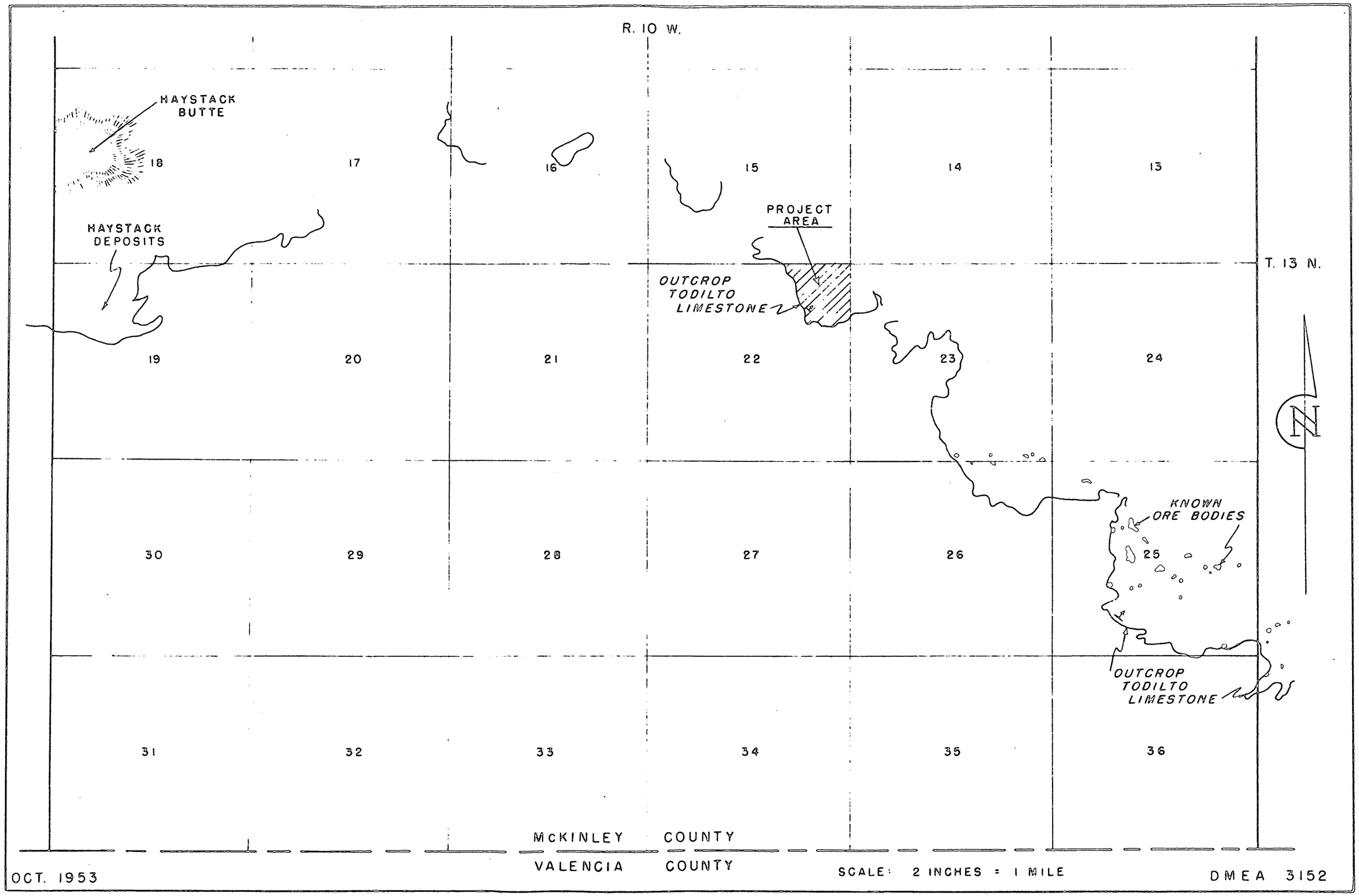

FIGURE 2. - OUTCROPS OF TODILTO LIMESTONE
(SHOWING SOME OF THE KNOWN ORE BODIES)

HANOSH MINES, INC. McKINLEY COUNTY, NEW MEXICO

No drilling on 25-foot centers, as proposed by the applicant, is suggested, as it is believed that drilling on 100-foot centers with some 50-foot offsets will find most average sized deposits or at least suggest their proximity. Closer spaced drilling, however, probably would be required to obtain a reasonably accurate appraisal of the tonnage and grade of deposits and certainly would be required to develop them for mining. It is believed that the applicant should be willing to do at his own expense the work he considers necessary to develop ore for mining if the greater risks of exploration have already been taken in the DMEA project.

The applicant has proposed to take no samples from the holes drilled on 100- and 50-foot centers, but rather to rely upon radiometric determinations by in-hole logging equipment to select the holes to be offset. Although the AEC field personnel have recommended this practice, and it has been accepted by the DMEA examining team for use on projects already studied, a more critical analysis of the logging method shows that it has not been thoroughly tested and proved. Furthermore, the AEC does not have the capacity to do the radiometric logging on this project whereas they have promised to do it on other DMEA projects, and the applicant proposes instead to use unproved logging equipment. The examining team therefore recommends that, in addition to the proposed radiometric hole logging, samples of the drill cuttings representing 2-foot intervals throughout the Todilto limestone be taken from all drill holes. This sampling will of course increase the cost of the project, but it seems necessary for the present in order to ensure obtaining adequate guidance for the drilling and to establish the reliability of the logging equipment.

STANDARD FORM NO. 64

Office Memorandum • UNITED STATES GOVERNMENT

TO : E. Wm. Ellis, DMEA Member, Uranium Commodity Committee

DATE: March 29, 1954

FROM : Arthur P. Butler, Jr., USGS Member, Uranium Commodity Committee

SUBJECT: Final Field Team Report DMEA Docket 3225 (Uranium), Ira N. Sprecher, Gallup, New Mexico, trustee, applicant, Group Claims, Sec. 2, T. 13 N. R. 11 W.

The applicant applied for $4,000 to explore the property identified above for uranium. The property was examined and the application denied by Region IV. W. A. Carlson, Acting Chief of the Grants Sub-Office, U. S. Atomic Energy Commission, accompanied the examiners and agreed with their conclusion that Government participation was not warranted.

Parts of the property are underlain by three formations, the Todilto, Morrison, and Dakota that are host rocks for uranium ore in the general area surrounding the claims. Most of the applicant's exploration was planned to explore the Dakota formation. The examiners found that black shales in the Dakota are slightly uraniferous, but found nothing to suggest that uranium was likely to be sufficiently concentrated to form ore bodies. The Morrison rocks on the property do not have features commonly considered favorable to ore, and exploration by the AEC in an adjoining section suggests that the Todilto is not sufficiently favorable to warrant exploration at the depth that prevails on the property. For those reasons, the examiners recommended and the Field Team denied the application.

I concur with the Field Team's conclusion and action.

Arthur P. Butler, Jr.

Copies to: E. Wm. Ellis (2)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

Mining Division
Region IV

March 10, 1954.

Memorandum

To: Field Team, Region IV

From: Chief, Mining Division, Region IV

Subject: Report of Examination - DMEA Docket 3225 (Uranium), Ira N. Sprecher, Group Claims, McKinley County, New Mexico.

Enclosed are eleven copies of the engineering report of examination on the subject docket.

The applicant requested $4,000.00 for a total of 4,600 feet of rotary drilling.

The engineer examiner concludes there is little chance that exploration would encounter significant uranium mineralization. The A.E.C. has drilled 40 holes immediately south of this property and no appreciable mineralization was found.

The engineer examiner recommends the application be denied and we concur in this recommendation.

W. H. King

W. H. King

Enclosures

Reviewed by
DMEA OPERATING COMMITTEE
3-19-54
(date)

Docket

Ching
Ellis

Project Summary Report

By: Michael Ching Date: August 6, 1957

1. Docket No. DMEA-3632 (Uranium)
   Contract No. Idm-E797

   Operator - Colamer Corporation, a Delaware corporation
   Commerce Building
   1016 West Santa Fe
   Grants, New Mexico

   Property - 27 unpatented mining claims, State Nos. 1-27, situated in sec. 8, T. 13 N., R. 9 W., N.M.P.M&B., McKinley County, New Mexico.

   Operator's Property Rights: Lessee. Owner's Consent to Lien signed by Thomas C. King and Phyllis J. King, Arthur W. Hyde and Vilatie W. Hyde, Lee Roy Cosper and Jane Hyde Cosper, J. V. Reynolds and Jean Reynolds, and Howard Deeds, a single man.

2. Contract (Short Form), dated May 17, 1955
   Final starting date, July 1, 1955
   Actual starting date, June 29, 1955
   Contract completion date, Sept. 15, 1956
   Termination Agreement, dated Jan. 22, 1957, effective July 20, 1956

   Work Authorized (as amended) - Test the Poison Canyon and Westwater Canyon sandstones of Jurassic age by core and non-core drilling in 3 stages as follows:

   Stage I - 78 holes

17,125 ft. non-core drilling @ $1.54/ft.	$26,372.50	
7,460 ft. core drilling @ $2.80/ft.	20,888.00	
20 chemical analyses @ $5/each	100.00	$47,360.50

   Stage II - 70 holes

15,750 ft. non-core drilling @ $1.54/ft.	$24,255.00	
4,900 ft. core drilling @ $2.80/ft.	13,720.00	
35 chemical analyses @ $5/each	175.00	$38,150.00

   Stage III - 60 holes

13,500 ft. non-core drilling @ $1.54/ft.	$20,790.00	
2,850 ft. core drilling @ $2.80/ft.	7,980.00	
30 chemical analyses @ $5/each	150.00	$28,920.00

   Estimated Total Cost of the Project $114,430.50
   Government Participation @ 75% $85,822.88

DMEA
DEPARTMENT OF THE INTERIOR
DEC 3 1956
REGION III
DENVER, COLORADO

FINAL GEOLOGICAL ENGINERRING REPORT

ON

DMEA DOCKET 3632 CONTRACT Idm-E797

RECEIVED
DEC 7 1956
D.M.E.A.

8/8/68

Hold for written authorization to release Operation Journal Report & [illegible] and check for 10^{00} to cover cost of reproduction & [illegible]

COLAMER CORPORATION

KELSEY L. BOLT,
CHIEF GEOLOGIST.

MONTH	PLUG (FT)	CORE (FT)	COST PLUG	COST CORE	COST ASSAYS
Feb.	1,860	704	$2,864.40	$1,971.20	$15.00
March	6,279	1,652	9,669.66	4,625.60	
April	462	168	711.48	470.40	
July	1,321	226	744.80	2,034.34	
Totals			$43,242.64	$35,466.34	$315.00

Total DMEA -$79,023.98

Government Participation: 0.75 x $79,023.98 = $59,267.99

ORE RESERVES

Following are the results of calculations of ore reserves discovered under this contract. The contour method was used. (See Ore body Map)

	Tonnage	Grade
Indicated or inferred reserves	71,422	0.221% U_3O_8
Possible reserves	29,111	0.157% U_3O_8

COLAMER CORPORATION

KELSEY L. BOLTZ
CHIEF GEOLOGIST

UNITED STATES
DEPARTMENT OF THE INTERIOR
DOUGLAS McKAY, SECRETARY

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SEP - 2 1955

DEFENSE MINERALS EXPLORATION ADMINISTRATION

REPORT OF EXAMINATION BY FIELD TEAM
REGION III

DMEA 3727, Santa Fe tracts

Santa Fe Uranium Company, Inc.

McKinley County, New Mexico

Uranium

Donald Haynes, Geologist
Geological Survey

Glen Walker, Mining Engineer
Bureau of Mines

August 1, 1955

Reviewed by
DMEA OPERATING COMMITTEE
9-9-55
(date)

Colorado Plateau District
P. O. Box 360
Grand Junction, Colorado

April 28, 1955

TRANSMITTED

A3529 1955

Memorandum

To: E. N. Harshman

From: T. E. Mullens

Subject: Preliminary report on DMEA 3727, Santa Fe Uranium Company, SW1/4 sec. 18, T. 13 N., R. 10 W., and N1/2 N1/2 sec. 13, T. 13 N., R. 11 W., McKinley County, New Mexico

The subject property was examined by a Region III examining team on April 26, 1955. The team consisted of Glen Walker, U. S. Bureau of Mines, and B. D. Haynes and T. E. Mullens, U. S. Geological Survey. The team was accompanied by Thomas Fife, Santa Fe Uranium Company engineer.

Briefly, the examining team will recommend some DMEA assistance to explore the SW1/4 sec. 18, but will not recommend DMEA assistance at this time to explore the N1/2 N1/2 sec. 13.

Santa Fe Uranium and the previous owners have done considerable work near some ore bodies in the central part of SW1/4 sec. 18. This work consists of a number of drill holes and an incline; however, none of the work was shown on the maps in the brochure with the exception of a "drill holes" notation. Without the location of the holes drilled and the incline, the examining team cannot plan an exploration program which would take advantage of previous work.

Mr. Fife told us that he had surveyed all holes on the property, but he has no map as he has not worked up his notes. Mr. Fife offered to send the Survey and the Bureau of Mines a copy of the map when he completes it. Then the examining team in connection with the company engineer could design a drilling program for the property.

As a matter of policy, I believe the map showing drill holes and incline should be included in the brochure. Thus, I recommend that DMEA write the applicant company and request 4 copies to go in the brochures. The maps should show the incline and drill holes. The drill holes should be divided into two classes: 1) drill holes which have been sampled and probed, and 2) drill holes which were not sampled or probed. The two classes are necessary as all records on some drill holes are lost and Santa Fe Uranium does not know what the holes penetrated. The map should also show the depth of the drill holes.

DMEA should also request that the company submit a drill hole map of the N1/2 N1/2 sec. 13. Nineteen AEC drill holes and several private drill holes have been drilled in this part of the section, and a map of these holes would complete the record. However, the examining team will not recommend any DMEA assistance for section 13 at this time.

T. E. Mullens
T. E. Mullens
Geologist

DMEA 3727

SANTA FE TRACTS
SANTA FE URANIUM COMPANY, INC.
McKINLEY COUNTY, NEW MEXICO

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Engineering report — Page

Introduction..... 1
Acknowledgements..... 2
Location, topography and physical features..... 2
History, production, and ownership..... 3
Description of deposits..... 4
Minable ore reserves..... 5
Present status..... 6
Project proposals with costs..... 7
Summary of project costs..... 10
Conclusions..... 10
Recommendations..... 10

ILLUSTRATIONS

Figure — Follows page

1. Location map of Santa Fe Uranium Co., property in McKinley County, New Mexico..... 2
2. Map showing property, outcrops of main formations, ore deposits and areas of A.E.C. drilling, Santa Fe Uranium Co., McKinley County, New Mexico..... 2
3. Map showing mine workings, old holes and proposed holes of Santa Fe Uranium Co., property in SW1/4 sec. 18, T. 13 N., R. 10 W., McKinley County, New Mexico..... 6

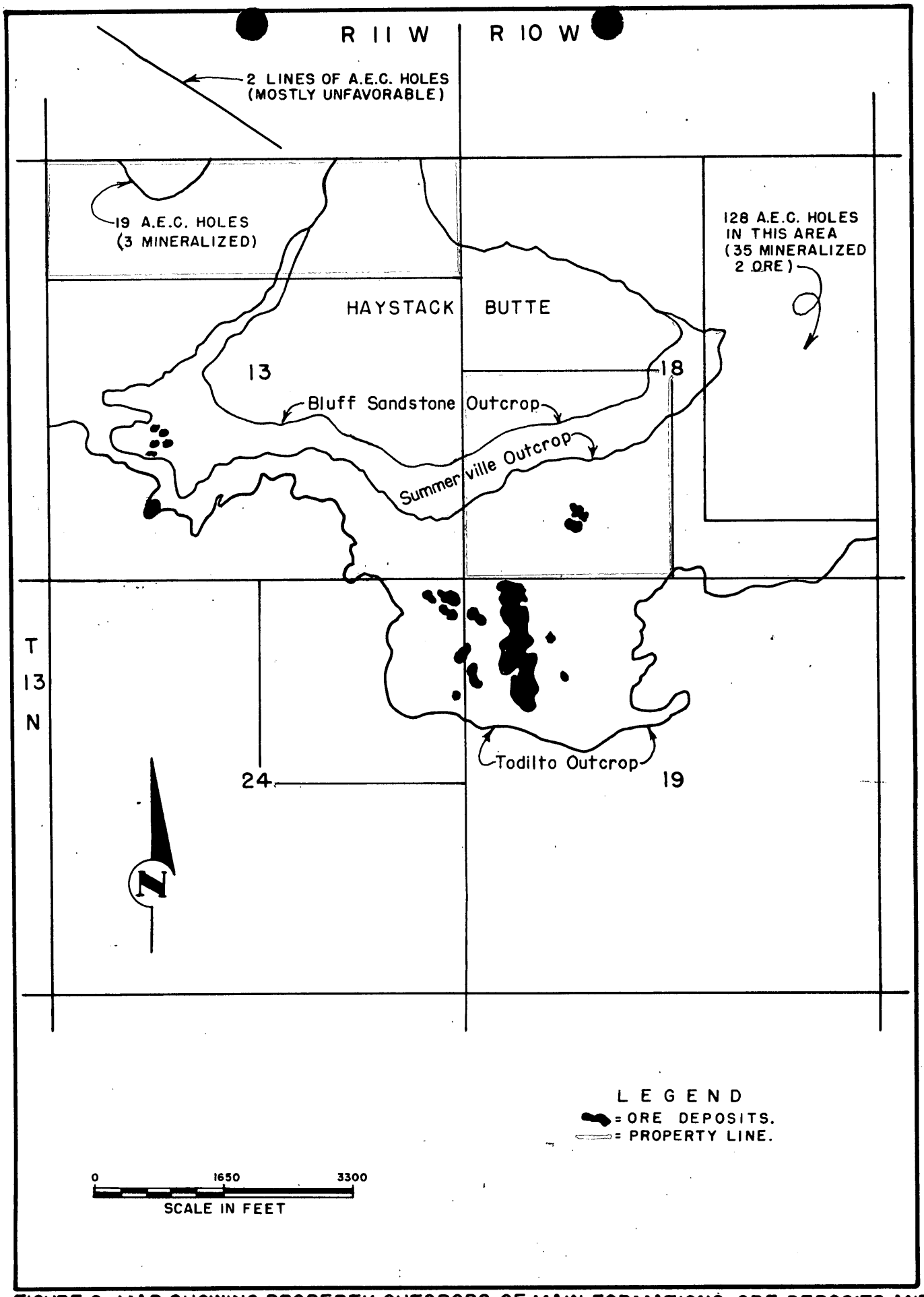

FIGURE 2-MAP SHOWING PROPERTY, OUTCROPS OF MAIN FORMATIONS, ORE DEPOSITS AND AREAS OF A.E.C. DRILLING, SANTA FE URANIUM CO., McKINLEY COUNTY, N.MEX. DMEA 3727

UNITED STATES ATOMIC ENERGY COMMISSION

RME-3050

FRACTURE PATTERN OF THE ZUNI UPLIFT

Final Report

By
Arthur K. Gilkey

June 1953

Columbia University
New York, New York

Technical Information Service, Oak Ridge, Tennessee

NOTE

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exhibit predominantly fracturing transverse to the fold axis while the second would show longitudinal fractures predominating. This criterion, or whatever other criteria would be found in its stead were to be applied to the Zuni uplift, as an approach toward understanding its origin. Then the other structural characteristics of the uplift were to be considered for any additional light they might provide.

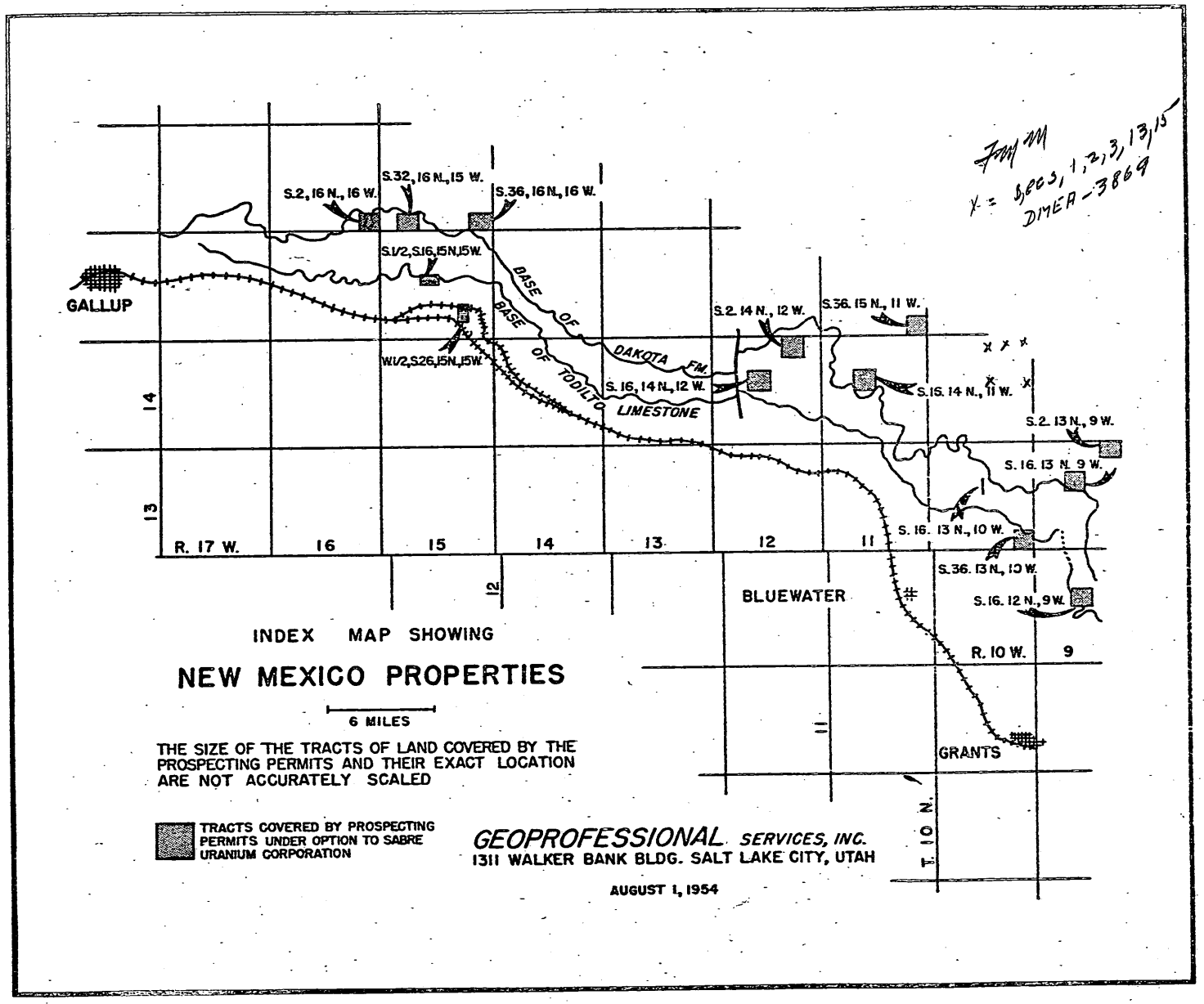
Specific Procedures and Data

The following structures were studied in the field as examples of smaller anticlines of known origin: for the laterally compressed type, one anticline in the Woods Hollow Mountains of the Marathon folded belt, west Texas, and a part of the Wills Mountain anticline in the folded Appalachians of northeastern West Virginia (a study done independently of this contract); and for the passively domed type, one laccolithic dome, Maze Arch, in the Henry Mountains of Utah. The data for these and for the Zuni uplift are presented on the attached maps, and the procedures and data will be described with reference to the individual maps.

Maps of the Zuni Uplift

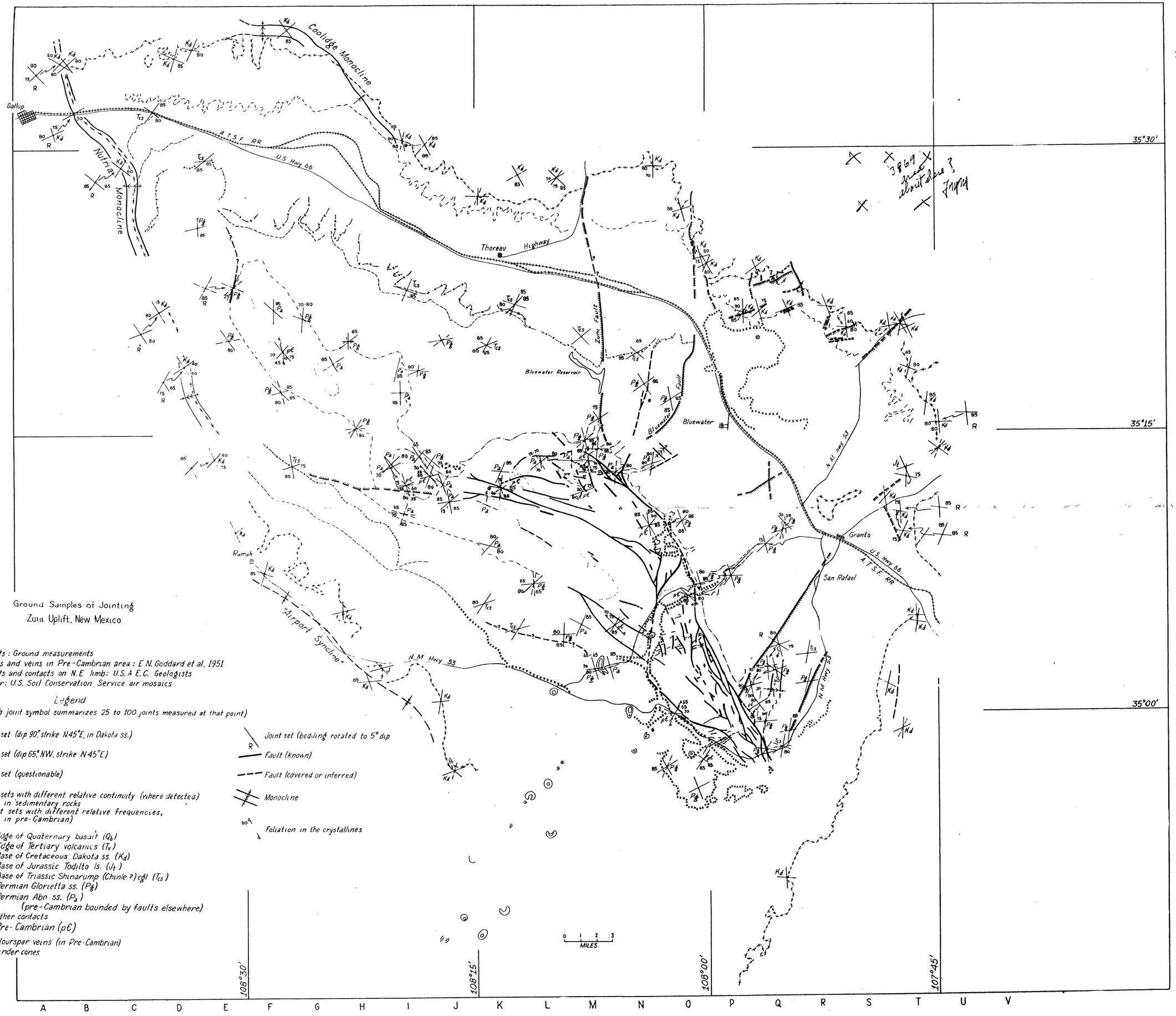
Ground Samples of Jointing, Zuni Uplift, New Mexico:

This map gives the most general picture of the Zuni uplift. On it are included as many of the major faults as could be compiled from other sources, in addition to those which were observed in the field, in the course of the joint measurements. Faults in the pre-Cambrian are taken entirely from the map of that region made by E. N. Goddard, et al (1951), and faults of part of the northeast flank are from maps by the U.S. Atomic Energy Commission geologists, Grants, New Mexico. Geological contacts, shown only where they could be confidently identified, were transferred by pantograph from controlled serial mosaics. Beyond these features, the map represents essentially a plot of the joint data. It cannot be regarded as a complete indication of the jointing which will be found in any given part of the



Fm M
X = S, Secs, 1, 2, 3, 13, 15
DMEA-3869

SABRE URANIUM CORP.
P. O. Box 1549
Grand Junction, Colo.



Ground Samples of Jointing
Zuni Uplift, New Mexico

Sources:

Joints: Ground measurements
Faults and veins in Pre-Cambrian area: E.N. Goddard et al. 1951
Faults and contacts on N.E. limb: U.S.A.E.C. Geologists
Other: U.S. Soil Conservation Service air mosaics

Legend

(Each joint symbol summarizes 25 to 100 joints measured at that point)

Kd — Joint set (dip 90°, strike N45°E, in Dakota ss.)

65 — Joint set (dip 65°, NW, strike N45°E)

Joint set (questionable)

Joint sets with different relative continuity (where detected) in sedimentary rocks
(Joint sets with different relative frequencies, in pre-Cambrian)

Edge of Quaternary basalt (Q_b)

Edge of Tertiary volcanics (T_v)

Base of Cretaceous Dakota ss. (K_d)

Base of Jurassic Todilto ls. (J_t)

Base of Triassic Shinarump (Chinle ?) cgl (T_{cs})

Permian Glorietta ss. (P_g)

Permian Abo ss. (P_a)
(pre-Cambrian bounded by faults elsewhere)

Other contacts
Pre-Cambrian ($p\epsilon$)

Flourspar veins (in Pre-Cambrian)

Cinder cones

R — Joint set (bedding rotated to 5° dip

Fault (known)

Fault (covered or inferred)

Monocline

60 — Foliation in the crystallines

UNITED STATES
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION
224 New Customhouse
Denver 2, Colorado

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8/6	Cheney	170

July 30, 1957

Memorandum

To: Chairman, Operating Committee, DMEA

From: DMEA Field Team, Region III

Subject: Docket No. DMEA 3939 (Uranium), Contract No. ~~Idm-E934, Food~~ Machinery and Chemical Corporation, Westvaco Mineral Products Division (Sec. 7, T 13 N, R 9 W), McKinley County, New Mexico - FINAL REPORT

Enclosed are the original and two copies of a joint final engineering and geologic report, dated July 1957, by H. F. Albee, Geologist, Geological Survey, and W. D. McMillan, Mining Engineer, Bureau of Mines; and transmittal thereof, dated July 26, 1957, from J. William Hasler.

The original and one copy of the Operator's final report were forwarded by memorandum of January 17, 1957.

The contract was terminated before completion of all the work provided for, by a TERMINATION AGREEMENT, dated January 9, 1957, which was made effective as of the close of business October 31, 1956.

The exploration work completed under the contract consisted of the drilling of 22 holes, aggregating 4,317 feet of non-core drilling and 1,157 feet of core drilling, and incidental allowance on a total of 5,474 feet of drilling, at a total accepted cost of $10,091.41, toward which the Government contributed 75%, or an amount of $7,568.56.

Final payment to the Operator was processed by this office March 5, 1957 in conformance with the Report of Review of reported project costs by the Contract Administration and Audit Division, DMEA, dated February 20, 1957.

The exploration work completed did not result in the discovery or development of a significant quantity of uranium ore; therefore, Certification of such under the provisions of the contract is not recommended.

E. N. Harshman

E. N. Harshman
Acting Executive Officer

Reviewed by
DMEA OPERATING COMMITTEE
8-5-57
(date)

FINAL F.T. REPORT

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UNITED STATES
DEPARTMENT OF THE INTERIOR
FRED A. SEATON, SECRETARY

DEFENSE MINERALS EXPLORATION ADMINISTRATION

JOINT FINAL REPORT OF EXAMINATION BY ~~EXAMINING TEAM~~
REGION III

DMEA 3939 CONTRACT Idm-E 934

FOOD MACHINERY AND CHEMICAL CORPORATION

Westvaco Mineral Products Division

Section 7, T. 13 N., R. 9 W., N.M.P.M.

McKinley County, New Mexico

Uranium

Joint Final Engineering and Geologic Report

by

H. F. Albee
Geological Survey

W. D. McMillan
Bureau of Mines

July 1957

Reviewed by
DMEA OPERATING COMMITTEE
8-5-57
(date)

1. In the vicinity of ore deposits the ore-bearing sandstones are 50 feet or more thick.

2. The ore-bearing sandstones are altered from a yellow brown or orange to a light gray color near ore deposits.

3. Mudstone in contact with ore-bearing sandstones is green or greenish gray near ore deposits instead of red or reddish brown.

4. Carbonaceous material, asphaltite, limonite, and claystone pebbles and seams are more abundant in the vicinity of ore deposits.

DMEA drilling disclosed an ore body in the northwest corner of sec. 8 in the Poison Canyon sandstone east of the Morrison formation by the Colamer Corporation on the State group of claims in sec. 8, T. 13 N., R. 9 W., N.M.P.M., DMEA docket 3632, contract Idm-E 797 (fig. 2).

The most pronounced standard feature on sec. 8 is a north-trending normal fault zone lying in the west half of the section. Considerable minor folding has occurred on sec. 8 and shows that small anticlines coincide with the axes of the thick sandstone zones thus suggesting that these small folds are a result of differential compaction rather than of original process. The ore deposit contains an estimated reserve of about 80,000 tons of uranium ore that will average 0.22 percent U_3O_8 and 8 feet in thickness. The ore deposit appears

to be about 1,000 feet long and averages about 150 feet wide with the long axis trending southeasterly. The depth to the ore body, from the surface, will be about 250 feet.

Section 10, T. 13 N., R. 9 W., N.M.P.M. was explored by DMEA under DMEA docket No. 4017, contract Idm-E 940, Colamer Corporation. Both the Poison Canyon sandstone unit and the Westwater Canyon member of the Morrison formation were tested in the Phyllis, Fannie, Jean, and Deetta claim groups in the same section with essentially negative results. This contract was completed and terminated without a certification of discovery.

WORK COMPLETED UNDER THE CONTRACT

Contract Idm-E934 was executed on March 21, 1956 and the project was started on April 16, 1956, with drilling beginning on June 20, 1956 and completed on October 23, 1956.

Stage I consisted of 15 non-core and core drill holes and Stage II consisted of 7 non-core and core drill holes. Total drilling under the contract was 4,317 feet of non-core and 1,157 feet of core in 22 holes. Details presented in Table No. I and hole locations are shown in Figure 2.

UNITED STATES
DEPARTMENT OF THE INTERIOR
Defense Minerals Exploration Administration
224 New Customhouse
Denver 2, Colorado

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April 8, 1958

Memorandum

To: All DMEA Engineers, Region III

From: DMEA Field Team, Region III

Subject: Semiannual Reports: "Investment Data" Heading

Quoted below is part of a letter from the Chairman, Operating Committee, DMEA, concerning a Semiannual Report of a project whose Operator is investing additional capital as a result of DMEA ore findings. The Chairman's comments refer specifically to the heading "Investment Data" on page 2 of the report.

> "The report gives a general picture of the underground workings completed and of equipment on hand, but, aside from the shaft, no investment costs are given.
>
> "In such cases as this we would like to have the approximate cost of development openings to date, of the steel headframe, and of the equipment on hand. We would be interested in knowing whether or not the Operator would object to supplying such information, and whether the examiners have been making direct requests for such data. Of course, the Operator should be assured that such information is to be used by the Government for general statistical purposes only.
>
> "Investment data should be presented in such a manner that it can be carried forward from period to period. Figures on the reporting form should be cumulative."

The comments should be considered when preparing Semiannual Reports in the future. We suggest that you review the Semiannual Report file of projects which are inspected by you and bring the Investment Data to date preparatory to the next inspection. Should your next inspection show that the Operator is investing additional capital in the project (directly or indirectly) as a result of DMEA work, please state under the heading "Remarks" on page 2 of the report the response of the Operator to your request for Investment Data.

Discovery of ore reserves resulting from DMEA work in many instances has lead to future exploration and development. The full report of additional investment data, therefore, will tend to establish the true effectiveness of the DMEA program.

MHM:jy
cc: DMEA,DFC - 10
DMEA,SLC - 4
DMEA,G.Jct. - 4
DMEA,TUC - 4

E. N. Harshman
E. N. Harshman

J. W. Townsend
J. W. Townsend
Acting Member

Amo

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OCT 29 1956

Treasure

URANIUM AND RESOURCES, INC.
531 SOUTH STATE STREET — SALT LAKE CITY 11, UTAH

DMEA

October 22, 1956

DEPARTMENT OF THE INTERIOR
OCT 24 1956
REGION III
DENVER, COLORADO

Mr. W. M. Traver, Exec. Officer
DMEA Field Team, Region III
U.S. Dept. of the Interior
224 New Customhouse
Denver 2, Colorado

Re: Docket DMEA 4411 (uranium)

Dear Mr. Traver:

In response to your request, we are enclosing three competitive bids for the proposed drilling of the NW ¼ Sec. 6, T.13 N., R.9 W., NMPM, New Mexico. It appears from the current bids in this area that we could revise our estimated non-core drilling costs downward from $1.50 per foot to $1.25 per foot. This figure, of course, includes the cost of circulation materials, drilling water, sample bags, and core boxes. We do not feel that the rate for core-drilling can be similarly adjusted.

We would like also at this time to advise you that we have received correspondence from the Bureau of Indian Affairs approving the transfer of the Uranium Mining Lease on the above land from New Park Mining Co. to Treasure Uranium & Resources, Inc. . We can furnish the Defense Minerals Exploration Administration a copy of this approval when it is desired.

Sincerely,

L. H. Baumgardner

L. H. Baumgardner, Geologist

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IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

December 9, 1957
Re: DMEA 4411 Idm-E1052
Treasure Uran. & Resources, Inc.
NW 1/4 Sec. 6, T13.N, R9W, NMPM
McKinley County, New Mexico
Uranium

Memorandum

To: E. W. Ellis, Defense Minerals Exploration Administration

From: N. E. Nelson, U. S. Geological Survey

Subject: Review of Field Team Final Report

The contract, awarded Jan. 17, 1957, approved the expenditure of $25,832.00 on the exploration by drilling of a quarter section of land underlain by Morrison formation. More particularly the exploration was concerned with rocks of the Brushy Basin and Westwater Canyon members of the Morrison formation as large uranium deposits occur in the Brushy Basin member in the area to the south (Grants) and to the north in the Ambrosia Lake area in the Westwater Canyon member.

As interpreted by the examiners, the referenced quarter section lies within a transitional zone in which, as determined by a large amount of drilling, much of it DMEA assisted, no large deposits of uranium minerals occur.

The property had been explored by 5 widely spaced drill holes. Gamma-ray logs showed mineralized material, as did 7 of the project holes. Two of 8 Stage I holes, D-6.5 and J-11, showed values in excess of 0.05, (0.051 and 0.055) U_3O_8 and one of 23 Stage II holes, C-13.5, showed 2 feet of 0.06% U_3O_8. Expenditures amounted to $18,444.84.

In the opinion of the examiners further work is not warranted and they recommend that the project be terminated without certification of discovery.

I concur with the opinion and the recommendation.

N. E. Nelson

N. E. Nelson

DMEA 4411
Contract Idm-E 1052

TREASURE URANIUM AND RESOURCES, INC.
SEC. 6, T. 13 N., R. 9 W., NMPM
McKINLEY COUNTY, NEW MEXICO

INTRODUCTION AND SUMMARY

Treasure Uranium and Resources, Inc., applied to Defense Minerals Exploration Administration for assistance in exploring for uranium ore on lots 3, 4, and the SE¼ NW¼, Sec. 6, T. 13 N., R. 9 W., NMPM, McKinley County, New Mexico. The applicant proposed to explore the underlying Morrison formation of Jurassic age by 17,000 feet of core and non-core drilling in 34 holes having an average depth of 500 feet, at an estimated cost of $34,500.00.

An inspection of the property was made on September 18, 1956, by a Region III DMEA examining team, consisting of Edward W. Buel, U. S. Bureau of Mines, and Howard F. Albee, U. S. Geological Survey, accompanied by Luke Baumgardner, geologist for the applicant.

The property had been partially explored by five widely spaced drill holes with mineralized material present in all holes as indicated by gamma-ray logs made by the U. S. Atomic Energy Commission. No chemical assay data were available and the examining team was unable to evaluate geological features of the ore-producing formations because of overburden. The geology and conclusions were based on previous DMEA contracts and private drilling in nearby areas which indicated that the property might

contain no significant uranium deposits. Thirty-one DMEA holes were drilled on the property; of these eight were weakly mineralized, but none showed ore-grade material.

ORE RESERVES

No uranium deposits were discovered by the DMEA project; consequently there are no ore reserves to be calculated, and therefore no certification of discovery will be recommended.

WORK COMPLETED UNDER CONTRACT

Contract No. Idm-E 1052 was executed on January 17, 1957. Work was started on March 2, 1957, and was completed on June 8, 1957. Stage I consisted of 2,016 feet of non-core drilling and 1,370.75 feet of core drilling, a total of 3,386.75 feet. Stage II consisted of 9,694 feet of non-core drilling.

Details of the drilling by stages are given in table no. 2, and the locations of the drill holes are shown in figure 4.

DMEA
DEPARTMENT OF THE INTERIOR
AUG 30 1957
REGION III
DENVER, COLORADO

FINAL DRILLING REPORT

NW¼ SEC. 6, T13N, R9W, NMPM, McKINLEY COUNTY, NEW MEXICO

DMEA CONTRACT Idm-E1052, DOCKET 4411 (URANIUM)

TREASURE URANIUM & RESOURSES INCORPORATED, SALT LAKE CITY, UTAH

During March, May and June, 1957, a total of 31 exploratory holes were drilled on the NW¼ Section 6, T13N, R9W, NMPM, McKinley County, New Mexico.

These holes were drilled under the provisions of a joint contract with the Defense Minerals Exploration Administration and Treasure Uranium & Resourses Incorporated, 531 South State Street, Salt Lake City 11, Utah. This contract, Idm-E1052, Docket 4411, provided that the DMEA would participate and be responsible for 75% of the authorized costs of the drilling project.

All holes were collared in the thin mantle of Recent alluvium that immediately overlies the Mancos formation and were bottomed in the upper five feet of the Recapture member of the Morrison formation. The Westwater Canyon member of the Morrison formation and a possible tongue of the Westwater that extends into the overlying Brushy Basin member (locally called Poison Canyon) were the drilling targets.

The drilling project was divided into two stages; the first consisted of eight drill holes that were plug-drilled to the approximate middle of the Brushy Basin member and cored from that horizon through the complete underlying Westwater Canyon member into the upper five feet of the Recapture member; the second stage consisted of twenty three holes that were plug-drilled the entire way to the Recapture member, with two-foot samples collected from the same intervals that the first eight holes were cored. All core and cuttings were properly labeled and stored with Four Corners Exploration Company a few miles west of Grants, New Mexico.

The following is a summary of all of the authorized operations and their costs incurred during the operation of the entire project.

OPERATION	UNIT	TOTAL UNITS	TOTAL COSTS	UNIT COST
Core Drilling	ft.	1370.75	4112.25	3.00
Plug Drilling	ft.	11710.00	9836.40	.84
Standby time	hr.	10.5	126.00	12.00
Chem. analyses	ea.	18	90.00	5.00
Core boxes	ea.	112	140.00	1.25
Incidental Allow	ft.	(Stage 1) 3386.75	2201.39	.65
" "		(Stage 2) 9694.00	1938.80	.20
		Total Project Cost	18444.84	

R-104A
(April 1952)

Budget Bureau No. 42-R1151.2

UNITED STATES
DEPARTMENT OF THE INTERIOR

SAMPLE

DEFENSE MINERALS EXPLORATION ADMINISTRATION

SAMPLE

OPERATOR'S UNIT COST AND PROGRESS REPORT

Month of _____ 195__ Docket No. DMEA 4411 Contract No. Idm-E1052

Operator's Name Treasure Uranium and Resources, Inc. Minerals Uranium

Address Salt Lake City 11, Utah

OPERATION	UNIT	COSTS THIS MONTH	UNITS THIS MONTH	COSTS TO DATE	UNITS TO DATE	UNIT COSTS TO DATE	AUTHORIZED BY CONTRACT	
							Units	Unit Costs
				STAGE I				
Non-core drill	ft.			1693.44	2016	0.84	2040	1.00
Core drill.	ft.			4112.25	1370.75	3.00	1510	4.00
Bulldozing	hr.			0.00	0	0.00	16	12.00
Standby time	hr.			42.00	3.5	12.00	8	12.00
Incid. Allow.	ft.			2201.39	3386.75	0.65	3550	0.65
Core Boxes	ea.			140.00	112	1.25	150	1.25
Analyses	Spl.			25.00	5	5.00	16	5.00
Auger				STAGE II				
Non-core drill	ft.	(Complete for		8142.96	9694	0.84	11,540	1.00
Bulldozing	hr.	current month		0.00	0	0.00	40	12.00
Standby time	hr.	and adjust Units		84.00	7	12.00	26	12.00
Incid.Allow.	ft.	and costs to		1938.80	9694	0.20	11,540	0.20
Analyses	Spl.	date.)		65.00	13	5.00	50	5.00
TOTAL DISTRIBUTED COSTS				18444.84				TOTAL COSTS AUTHORIZED BY CONTRACT
Operating Equipment Purchased								
Initial Rehabilitation and Repairs								
New Buildings, Improvements, etc.								
TOTAL COSTS				18444.84				

The undersigned company, and the official executing this certification on its behalf, hereby certify that the information contained in this report is correct and complete to the best of their knowledge and belief.

Date _____ Operator _____

Per _____ Title _____

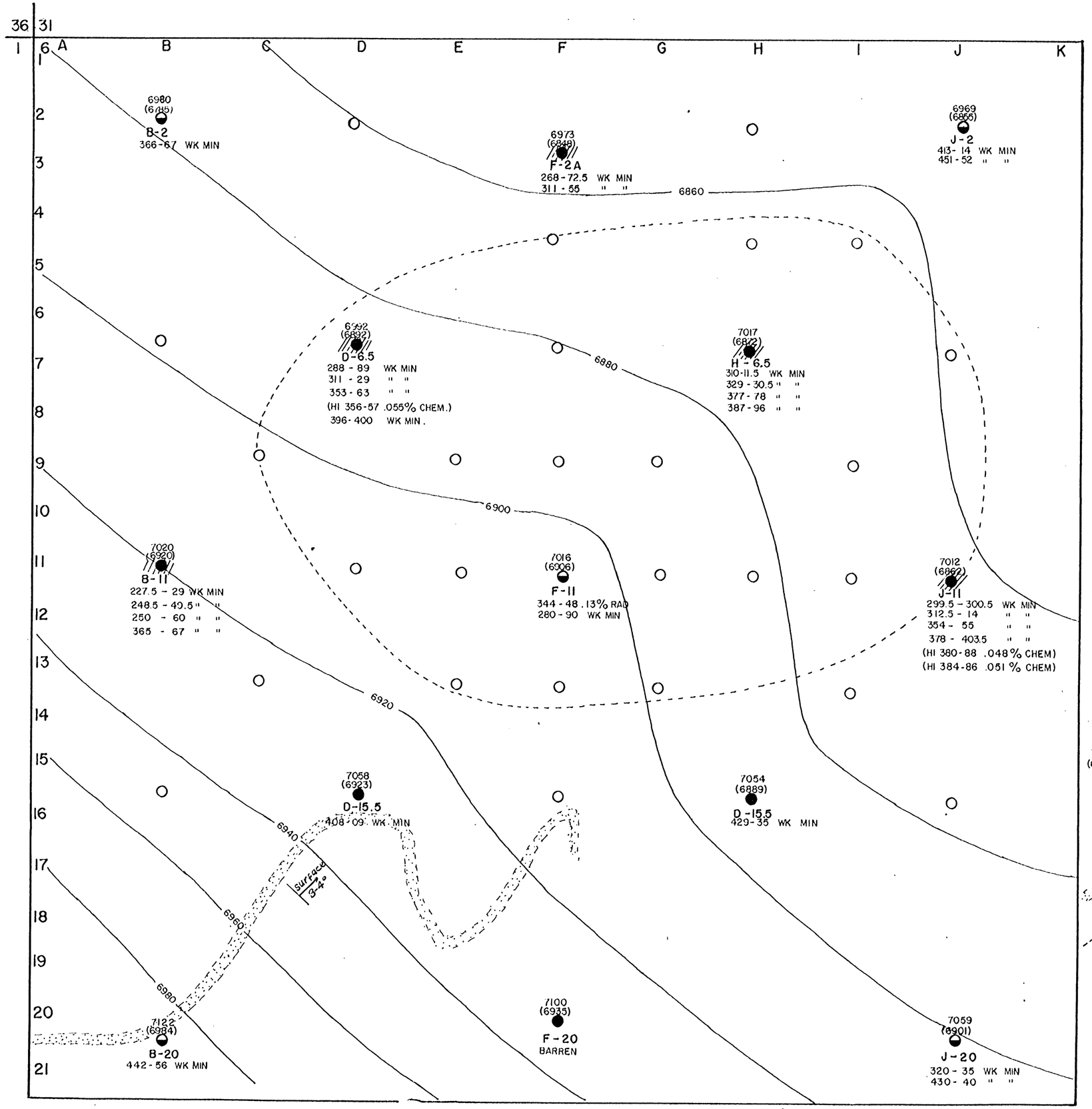
NOTE.—Title 18, U. S. Code (Crimes), section 1001, makes it a criminal offense to make a willfully false statement or representation to any department or agency of the United States as to any matter within its jurisdiction.

REMARKS:

(Instructions on reverse)

(For Government use only)

RECEIVED JUL 1957 D.M.E.A.



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TREASURE URANIUM & RES. INC.
SALT LAKE CITY

DRILL HOLE & STRUCTURE MAP
Contoured on top of Dakota ss

NW 1/4 SEC 6 T13N R9W NMPM

MCKINLEY CO., NEW MEXICO

DMEA HOLES WITH FAVORABLY BLEACHED SANDS

DMEA DKT 4411 HOLES DRILLED DURING MARCH '57

PREVIOUS HOLES (3/'56)

PROPOSED HOLES

7100 SURFACE ELEV.
(6900) ELEV TOP KD

CONTOUR INTERVAL 20' SCALE 1"=200'

APRIL 1957 M. HEMMINGER

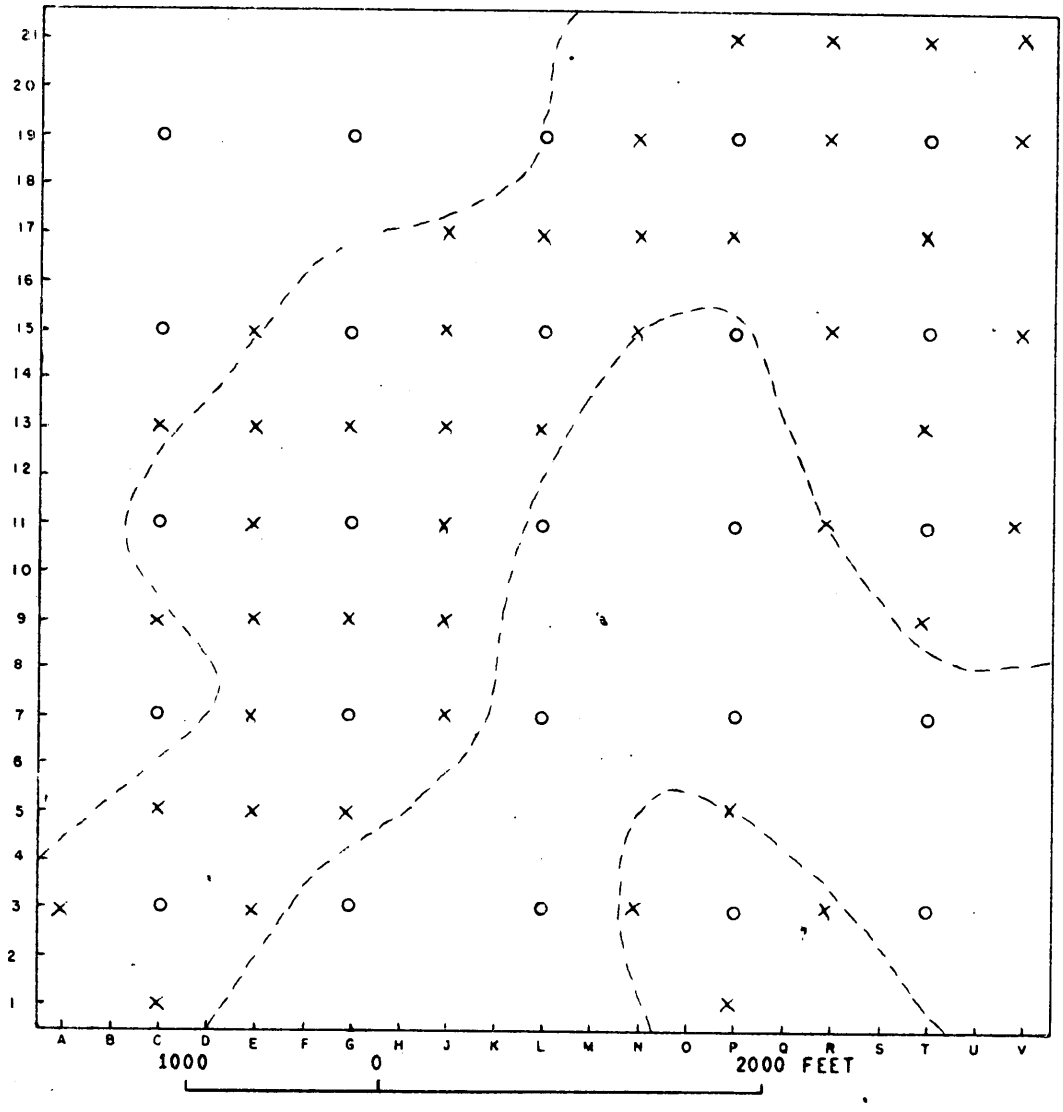
20-40' TRES HERMANOS LEDGE

OUTLINE OF FAVORABLE AREA

Mch

U. S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

DEFENSE MINERALS EXPLORATION ADMINISTRATION
MARCH 1957 DOCKET 4590



EXPLANATION

100 cps ISORAD LINE

DRILL HOLES

O DRILLED BY COMPANY

X PROPOSED STAGE I DRILL HOLE

FIGURE 3.—MAP OF SECTION 34, T.14N., R.10W., N.M.P.M., SHOWING LOCATION OF PROPOSED STAGE I DRILL HOLES, NEW JERSEY ZINC COMPANY, McKINLEY COUNTY, NEW MEXICO.

SAN MATEO CREEK BASIN LEGACY URANIUM MINES SUPERFUND SITE
ENCLOSURE 2

TABLE: MINES WITHIN THE SITE BOUNDARY

Company	Mine	Location (Study Area)
United Nuclear Corporation	Ann Lee, Cliffside, Dysart No. 1, Dysart No. 2, Isabella, John Bully, Mary No. 1, Sandstone, Section 10, Section 12, Section 13, Section 15, Section 23, Section 25, Section 27, Section 29, Section 32, Section 33	Ambrosia Lake
	Faith, Flea, Isabella South	Poison Canyon
	Hogan, Marquez, San Mateo	Upper San Mateo Creek
ConocoPhillips Company	Ann Lee, Cliffside, Isabella, John Bully, Sandstone, Section 24, Section 29, Section 33	Ambrosia Lake
	Section 13, Faith, Isabella South	Poison Canyon
	Doris	Lower San Mateo Creek
	Chill Willis	Upper San Mateo Creek
Hecla Mining Company	Isabella	Ambrosia Lake
	Hope, Isabella South, Section 36	Poison Canyon
	Johnny M	Upper San Mateo Creek
	Doris	Lower San Mateo Creek
Homestake Mining Company	Ann Lee, Dysart No. 1, Dysart No. 2, Mary No. 1, Section 10, Section 13, Section 15, Section 23, Section 25, Section 27, Section 30, Section 32	Ambrosia Lake
	Flea	Poison Canyon
	Hogan, San Mateo	Upper San Mateo Creek
Layne Christensen Company	Dysart No. 2, Isabella, Mary No. 1	Ambrosia Lake
Rio Algom	Section 10, Section 17, Section 19, Section 22, Section 24, Section 30, Section 30 West, Section 33, Section 35	Ambrosia Lake
	Section 23, Section 25,	Poison Canyon
	Marquez	Upper San Mateo Creek
Chevron Corporation	Mt. Taylor	Upper San Mateo Creek
Rio Grande Resources (El Paso Natural Gas)	Mt. Taylor, San Mateo	Upper San Mateo Creek
Holly Minerals Corporation	Bucky	Ambrosia Lake
Cobb Resources Corporation	Bucky, Dysart No. 2, Section 10, Section 12	Ambrosia Lake
	Section 32, Section 33	Tronox

SAN MATEO CREEK BASIN LEGACY URANIUM MINES SUPERFUND SITE
ENCLOSURE 3

FEDERAL NOTICE LETTER RECIPIENTS

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Solicitor
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Washington, D.C. 20240

PRIVATE PARTY NOTICE LETTER RECIPIENTS

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Houston, Texas 77079

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Chevron USA, Inc.
Michelle Bacon, Attorney
Chevron USA, Inc.
6001 Bollinger Canyon Road
San Ramon, California 94583

Homestake Mining Company
Patrick Malone, Attorney
Homestake Mining Company
310 Main Street, Suite 1150
Salt Lake City, Utah 84101

Rio Grande Resources
Rio Grande Resources Corporation
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Grants, New Mexico 87020

Holly Minerals
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Cobb Resources
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