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FINAL REPORT ON COMPLETED CONTRACT

by

M. L. Burmeister and Robert D. Trace[1/]

DMEA Docket No. 3855 (Thorium, uranium and rare earths)
Contract No. Idm-E 914
Operator: William G. Reynolds, Stonegate Road, Anchorage, Kentucky
Property: Hicks Dome, Hardin County, Illinois

Summary

The purpose of this exploration was to investigate at moderate depth the economic potential of a vein-like occurrence containing thorium, rare earths and uranium minerals.

Exploration was conducted in section 30, T11S-R8E, Hardin County, Illinois on ground held by the operator under a lease of mineral rights (fig. 1). "Owner's Consent to Lien" was waived, but "Subordination Agreements" were executed.

Contract amendment No. 1 provided that the date of commencing work be extended from March 15 to May 1, 1956, and changed the number and allowable cost of chemical and spectrographic determinations. Amendment No. 2 extended the time for completion of the contract to October 1, 1956.

Work was divided into two stages. Stage I as accomplished consisted of bulldozing two main and two spur trenches for an aggregate length of 730 feet, in the course of which a total of 12,332 cu. yds. of material was removed, of which 652 cu. yds. was for the operator's account.

1/ M. L. Burmeister, Engineer, U. S. Bureau of Mines
Robert D. Trace, Geologist, U. S. Geological Survey

Reviewed by
DMEA OPERATING COMMITTEE
(date)

Results obtained in Stage I justified diamond core drilling two holes. Drilling totaled 406 feet, of which one foot was for the operator's account. A total of 41 chemical or spectrographic determinations was made (fig. 2a). Total cost of the project was $4,610.00.

In diamond drilling both holes a number of either actual cavities or clay-filled cavities were encountered. The engineer was present on two such occasions when the drill dropped suddenly. It is believed that open cavities were encountered because of immediate but temporary loss of drilling water, and the fact that no clay appeared in the returning water.

Conclusions and Recommendations

No further DMEA participation in the subject project is recommended. Although the past exploration strongly suggests that a vein of thorium and rare earths is present, the vein consistently is not of minable width. In addition, nothing suggests that the vein will widen in depth, as evidenced by the consistent width of about 1 foot along trench 1 and in D.D.H. 1. As the exploration did not get below the oxidized part of the vein and no definite results were obtained by mineralogical study, nothing can be predicted about the grade of the unoxidized vein.

Any further exploration would have to be deep drilling (at least 400-500 foot holes), in order to explore the unoxidized veins, or a shaft; neither is justified, in the light of our present knowledge.

The exploration project did not find an economic ore deposit and therefore no certification of discovery is recommended.

Work Provided for in Contract

Work under this contract was divided into two stages. Stage I provided for the removal of a maximum of 11,700 cu. yds. of material from two trenches by bulldozing methods. Stage II was dependent upon results obtained in Stage I and provided for diamond core drilling a maximum total of 405 feet in one or two holes. A total of 95 chemical and 32 spectrographic determinations was allowed for the entire contract. A topographic map was to be made of the exploration area and was provided for.

Description of Work Completed

Work under this contract started April 14 and was completed August 20, 1956. In Stage I there were completed two main trenches, No. 1 and No. 2, and two smaller spur trenches from No. 2 (figs. 3, 4, 5). Trenches No. 1 and No. 2 were made on the strike of two separate lines of mineralization and the spur excavations of trench No. 2 followed indicated branches of the main line of mineralization.

Trench No. 1 is 350 feet in length and averages 26 feet wide and 27 feet deep inside the approaches. Trench No. 2 is 230 feet in length and averages 29 feet wide and 21 feet deep between approaches. The spur trenches are of lesser dimensions, as is shown in fig. 3. The presence of chert along the course of mineralization made necessary the nearly constant use of scarifying teeth on the bulldozer blade. Partially because of increasing hardness of the ground, and partially because of contract yardage limitations, trenching was stopped after excavating the contract amount of 11,700 cu. yds. plus 652 cu. yds. for the operator's own account.

Radioactivity was measured with a Precision Model 111B Scintillator. In trench No. 1 between points 0+00' and 2+50' and from several feet below the surface to trench bottom, the one-foot width of greatest radioactivity averaged approximately 1 MR/hr, or 77 times the background of 0.013 MR/hr, and the 2-foot widths adjoining on each side averaged about 0.41 MR/hr, or 32 times background. On this basis, radioactivity for a total width of 5 feet and a length of 250 feet might measure an average of 0.53 MR/hr, or 40 times background.

Results obtained in Stage I were considered sufficiently encouraging to justify diamond drilling in Stage II (figs. 6, 7, 8).

Stage II provided a total of 405 feet of AX size diamond core drilling which could be done in either one or two holes. Although information which might be gained from deeper drilling was desirable, it was concluded that two more shallow holes would decrease the possibility of obtaining unrepresentative results which would almost certainly be obtained in one drill hole. The locations of holes No. 1 and No. 2 are shown on fig. 3. Hole No. 1 was drilled 211 feet on a bearing of S 62° W and at a -60° inclination. The hole penetrated to a point 10 feet beyond the vertical projection of mineralization in the bottom of the trench. Hole No. 2 was drilled 195 feet on a bearing of S 62° W and at a -50° inclination. The hole penetrated to a point about 25 feet beyond the vertical projection of mineralization in the trench bottom (fig. 9 a, b, c).

A number of open or possibly clay-filled cavities were encountered in each hole. No core was obtained in these sections. Efforts to obtain a drill

hole probe were unsuccessful in the time the drill could be held to keep the hole open for probing. If a probe had been used, it is highly probable that it could not have been recovered.

Geology

General Area

The Reynolds property is near the center of Hicks Dome, which is in the northern part of the Illinois-Kentucky fluorspar district. The name Hicks Dome refers to a small domal uplift in northwestern Hardin County, southern Illinois.

Rocks of the Illinois-Kentucky fluorspar district are mostly sedimentary and range in age from Devonian to Cretaceous. Some dikes, sills, and irregularly shaped bodies of mica-peridotite and breccias of sedimentary and both femic and mafic igneous materials are present. Structurally, the area is a low oval-shaped dome broken by a series of northeast-trending high-angle faults that displace the beds as much as 2,000 feet. The beds range in dip from essentially horizontal to about 15 degrees, except near faults where dips may be nearly vertical.

Hicks Dome, in the northern part of the fluorspar district, is a small structural uplift that is superimposed on the larger dome that comprises the entire fluorspar district. The central part of Hicks Dome is about a mile in diameter and is underlain by cherty limestone and siliceous shale of Devonian age (fig. 10); the shale is well exposed in several places, but only cherty overburden crops out in the part of the central area underlain by limestone.

Mississippian and Pennsylvanian limestone, sandstone, and shale dip as much as 15 degrees and crop out in a circular pattern around the Devonian rocks, except to the southeast of the Dome, where northeast-trending faults break the circular continuity (Ill. Geol. Survey Bull. 76).

Hicks Dome probably is the result of deep-seated igneous activity -- either an intrusive body that is more than 3,000 feet below the surface, or an incipient or uncompleted cryptovolcanic structure. Evidence for the igneous activity is the perioditite dikes and the igneous and sedimentary breccias (diatremes?) that are present in the vicinity of Hicks Dome (Ill. Geol. Survey R. I. 197).

Within the area underlain by Devonian limestone, fluorspar has been produced only from the Rose mine (fig. 10). This mine was operated more than 30 years ago and no reliable information is available regarding its occurrence.

Project Area

In order to make this final report as complete as possible, some of the data from an interim report by Dewey H. Amos, U.S.G.S., and from the examination report are summarized herein.

The project area is near the center of Hicks Dome and is underlain by cherty and dolomitic limestone of middle Devonian age. No exposures of limestone were found at the surface or in trenches 1 and 2, as the overburden near the center of the Dome is about 75 feet thick. Unweathered limestone, however, was cut in D.D.H. 1 and 2.

The formations beneath the near-surface limestone are described by Brown and others (Econ. Geol. v. 49, no. 8) from cuttings of the Hamp hole

(figs. 3 and 10). In summary this hole penetrated Devonian, Silurian, and Ordovician sediments from the surface to 1,605 feet; from 1,605 to 2,944 the hole penetrated a breccia zone which contained traces of fluorite, calcite, quartz, pyrite, sphalerite, galena, and thorium and several rare-earths (fig. 11).

Faults that trend northeast are common in the Mississippian and Pennsylvanian rocks surrounding the Dome, but because of the lack of bed-rock exposures in the center of the Dome, it is not known whether these faults extend through its center. Data from trenches 1 and 2 and D.D.H. 1 and 2 (fig. 3) show that faults are present within the center of the Dome, but the explored area is not sufficiently large to demonstrate that these faults continue to the edge of the Dome.

The initial exploration on the property (other than the Hamp hole) was a bulldozer cut on the side of a small hill; in the examination report, the radioactivity in this cut was called anomaly 100. This cut is now the extreme southeast end of trench 1 (fig. 3). Nearly vertical zones of varying radioactivity were exposed at anomaly 100 which from southwest to northeast are as follows: zone 1 - 3 feet wide, eU 0.019; zone 2 - 16 inches wide, eU 0.094; zone 3 - 4.5 feet wide, eU 0.030; zone 4 - 5 feet wide, barren; zone 5 - 16 inches wide, eU 0.042 (fig. 11, Reynolds 1-6).

The Hamp hole sump (fig. 3) also contains scattered 1- to 2-foot areas of radioactivity.

Trench 1 was started at anomaly 100 and was excavated northwestward, following the zone of high radioactivity. A vein-like body (hereafter called

a vein) consisting of yellow-brown clay-like and silty material is exposed that is at least 260 feet long and 1/2 to 2 feet wide (zone 2). The attitude of the vein is somewhat irregular but has an average strike over its exposed length of N 24° W and a dip of about 85° to the northeast. Average microroentgen counts on a scintillator (Model 111B) across the vein ranged from 800 to 1,200 per hour against a background count of 18 microroentgens. For 1 to 6 feet on each side of the vein the overburden from the country rock has a count of 400-800 microroentgens (zones 1 and 3).

At least four gravity-type faults with displacement of one-half to 2 feet intersect the vein (fig. 3). These faults strike about N 70° E and dip 75° to 85° southeast. The highest radioactivity readings are obtained at the intersection of these faults with the vein, although the faults are not radioactive away from the vein.

Assays of trench samples were made by C. O. Parker, Denver, with check samples by Lindsay Chemical Company and the U.S.G.S. (fig. 2 a and b). According to the Parker assays of the vein, the thorium ranges from 0.09 to 0.47 percent, averaging about 0.2, and the combined rare-earths ranges from 0.38 to 1.47 percent, averaging about 0.9. Check samples by Lindsay Chemical Company and the U.S.G.S., however, suggest that these figures should be doubled, and that the average content of the vein probably is about 0.4 percent thorium and about 2 percent combined rare-earths.

Although the country rock in trench 1 is weathered, i.e., the carbonate content has been removed, the original attitude of the limestone beds is suggested

by the attitude of the chert layers that remain. Their attitude varies greatly within short distances, but in general southeast of the intersection of D.D.H. 1 and the trench (fig. 3), the beds dip 5 to 10 degrees to the southeast, and northwest of this point, the beds dip 15 to 20 degrees to the northwest. Locally, the layers are completely folded.

Trench 2 failed to reveal a significant extent of radioactivity. A few localized spots of high radioactivity associated with yellow clay are present in the southern end of the cut. These spots have neither vertical nor lateral extent, nor indicate any systematic distribution or trend. No faults are present in this trench. Weathered country rock in the southern end of the trench is brecciated.

Two core drill holes (fig. 9 a, b, c) were put down to test the vertical extent of the vein exposed in trench 1. No core was recovered from these holes that contained the high radioactivity found at the surface, although breccia zones with slight radioactivity were found.

In D.D.H. 1, the zone of greatest brecciation is from 176.5 to 183 (probably corresponds to zone 3 at anomaly 100). The core consisted of angular fragments of limestone and chert with many veinlets and small cavity fillings of purple fluorite and white calcite. Radioactivity is as much as 0.009 eU. The interval of 183-184 (zone 2?) is reported by the driller as a cavity. The interval 184-193 (zone 1?) also is brecciated and contains calcite and fluorite, but in lesser quantities than zone 3. The cavity at 183-184 (zone 2?) is approximately the width of the highly radioactive vein in trench 1

and at anomaly 100, and is also in the same relative position within the entire radioactive zone.

D.D.H. 2 also cut breccia zones with fluorite and calcite and some radioactivity, but except for 0.6 foot no core was obtained from zones 1, 2, and 3. The vein probably is somewhere in the 139.6-161 interval which was reported as a cavity. This interpretation is based upon (1) the anticipated position of the radioactive zones from data in D.D.H. 1, and (2) the core from the interval 139.0-139.6 was highly brecciated, similar to the 176.5-183 (zone 3) interval in D.D.H. 1. The breccia zone in D.D.H. 2 was cut about 25 feet higher than in D.D.H. 1 and was therefore subject to more complete weathering; this could account for the lack of core or cavity.

In both D.D.H. 1 and 2, a narrow zone of radioactive breccia was cored that is 5 to 10 feet horizontally east of the zones 1, 2, and 3. This probably corresponds to zone 5 at anomaly 100.

The highest radioactivity in both holes is in zone 5 (D.D.H. 1 156.0-156.1, eU 0.013; D.D.H. 2 127.9-128, eU 0.018) that seemingly parallels the wider breccia zone.

The core drilling proves that the vein in the overburden has vertical continuity, as shown by the localization of breccia and radioactivity. The vein, however, was cut at too shallow a depth (i.e., about 125' below the trench). Although the wall rocks are unweathered at this depth, the highly radioactive vein probably has either been weathered completely and washed out by surface water, or was so soft that it could not be cored. This phenomenon is common; for example, fluorspar veins in the area are known to weather as deep as

300 feet and yet have solid rock walls. For an individual case, however, the depth of weathering is difficult to predict.

Mineralogy

The mineralogical work is described in three parts: (1) samples from the Hamp hole, (2) samples from the surface at anomaly 100, and (3) a sample from the drill core.

The pulps of the Hamp hole (drilled in 1952) were obtained from the U.S.G.S. laboratory in Denver. Assays for eU, U, and CaF_2 had been made by the U.S.G.S. and published by Brown in Economic Geology. Semiquantitative spectrographic analyses also had been made, although except for thorium they were not published by Brown (fig. 11, Hamp 1-8). At the writer's request, the Washington laboratory of the U.S.G.S. studied the minerals in these pulps, as they contain more thorium and probably rare-earths normally found in sediments. A study of the mineralogy might determine whether the thorium and rare-earths are in primary minerals like monazite or bastnaesite, or whether they are adsorbed on amorphous iron oxide or clay-like material that was carried into position by surface water, possibly from the formerly overlying Devonian shale.

The Hamp sample pulps had been ground to pass a 150-mesh screen and therefore the minus 100 plus 200-mesh fraction was small. According to Miss Regina L. Wack, mineralogist of the U.S.G.S.: "In the minus 100 plus 200-mesh fraction quartz, calcite, fluorite, pyrite and magnetite were identified. Biotite is present in samples (Hamp) 2 and 4 and barite in sample 4. No rare earth minerals could be identified."

The only previously unreported mineral is biotite. The Harap hole probably penetrated a narrow dike of mica-peridotite, as they are known to occur less than a mile away.

A study was made of the mineralogy of the most radioactive sample at anomaly 100 (Reynolds 3, fig. 11), which contains about 2 percent combined thorium and rare-earths. Semiquantitative spectrographic and X-ray analyses were run on the heavy (in methelene iodide) fraction of the sample. The combined thorium and rare-earth content was raised from about 2 percent in the original sample to about 7 percent in the heavy fraction. By X-ray work, however, only goethite and hematite were definitely identified. Some X-ray lines are present that might indicate monazite, and the relative quantities of the various rare-earths (Ce, La, Nd, and Pr) shown in the spectrographic analysis of the heavies are suggestive of monazite also. No definite identification, however, could be made.

X-ray and spectrographic work was done on the most radioactive core sample, D.D.H. 2, 127.9-128.0, eU 0.018. This 0.1-foot zone is stained brown and is dominantly calcite with subordinate quantities of silica, iron oxide, and traces of barite, and an unknown mineral. Work is continuing on this sample, although the quantity of the sample is so small and the quantity of the unknown mineral in the sample also is so small that conclusive results may not be obtained.

The laboratory work on the above sample was as follows: The sample was crushed and screened into six size fractions by using 40-, 80-, 120-, 200-, and 300-mesh screens. The radioactivity of these fractions was measured by

a portable Geiger counter with attached scalar. The plus 200 fractions are about twice background, whereas the minus 200 plus 300 and minus 300 fractions are three to four times background.

A further separation of the two finer fractions was attempted by centrifuging in bromoform. In both samples, the small quantity of heavies obtained was insufficient for measurement of their radioactivity, so no comparison of relative radioactivity of the heavies and lights could be made. Both of the light fractions, however, were still radioactive. Therefore, both the light and heavy fractions were used for additional study.

The plus 200 fractions also were split by centrifuging in bromoform, but no results could be obtained from them. The quantity of heavies was extremely small -- a few grains. The light fractions were larger in quantity, but all the material was heavily coated, making microscope examination useless. In order to remove the coating, the material was boiled in concentrated HCl. The residue was entirely quartz grains and a small quantity of an amorphous brown clay-like material, probably iron oxide.

The minus 300 light fraction was examined by X-ray work; although the material was radioactive, only calcite was found. The radioactivity likely is in the amorphous clay-like coating, or possibly thorium may be substituting for calcium in the calcite lattice. (When this sample was digested in HCl, the clay-like material remaining was so small in quantity that its radioactivity could not be measured.)

The plus 300 minus 200 light fraction was also X-rayed, but only calcite and quartz were identified.

The plus 300 minus 200 heavy fraction was only a few grains and no results could be obtained.

The minus 300 heavy fraction was X-rayed. A small quantity of calcite and quartz was found, and also barite and an unknown mineral. As the X-ray card files at the writer's office in Beltsville are incomplete, this sample was sent to the U.S.G.S. Washington laboratory. They found the same X-ray pattern as the writer, but as yet, they cannot identify the unknown mineral.

The data now known suggest that at least most of the radioactivity in the drill core sample is in the brown iron oxide coating, although the unidentified mineral also may be radioactive.

Origin of Mineralization

Three possible origins for the weathered occurrence of the thorium and rare earths have been suggested: (1) a weathered vein deposit localized along breccia or fault zones and related to the deep-seated igneous or explosive activity, (2) fissure filling by surface waters that carried minerals downward from the stratigraphically higher Devonian shale, and (3) mica-peridotite dikes, which contain a small quantity of rare earths.

Although the weathered vein trends northwest, which is the common trend for dikes in the area, the following data suggest that the weathered vein is NOT a dike and that the weathered vein might have at best only a distant relationship with dikes in the area, that is, a common igneous origin.

(1) No mica has been found in the trench or core drill holes. In the known dikes, however, mica is extremely resistant to weathering and always can be found in the surficial material overlying the dikes.

(2) In comparing spectrographic analyses of two dike samples to similar analyses of the weathered vein (fig. 11), the known dikes contain considerable nickel and chrome, whereas the weathered vein contains only minute quantities.

(3) The dikes contain the rare-earth-bearing mineral perofskite, but no thorium is known to be present, as in the weathered vein.

(4) No mica-peridotite was found in the drill core, although possibly it could have been so completely weathered as not to core.

Possibly the weathered vein could be a fissure and breccia zone that has been filled with material by mineral-bearing water percolating downward from the Devonian shale. This shale is known to be slightly radioactive and probably overlaid the project area prior to doming.

The thorium (and associated rare earths) probably did not come from the Devonian shale, however, because: 1) According to Frondel (U.S.G.S. Prof. Paper 300, p. 575) "thorium, unlike uranium, is not a significant constituent of the carbonaceous marine black shale . . . ." 2) Thorium is relatively insoluble and probably would not migrate downward from theDevonian shale, and 3) Considerable pyrite is present in the Hamp samples, suggesting that little if any oxidation has taken place at the sampled depths and therefore it is unlikely that thorium-bearing surface water ever reached these depths.

The following factors suggest that the thorium and rare earth vein was formed by migration of mineral-bearing material upward along breccia and fault zones which resulted from deep-seated igneous or explosive activity.

Exploration in trench 1 showed that, as is common with veins, the highly radioactive zone is continuous and consistently mineralized horizontally for at least 260 feet, and D.D.H. 1 and 2 show that the radioactivity has vertical continuity of over 100 feet and is localized along breccia and fault zones.

Regarding continuity, the breccia zone in trench 1 may be the same general zone that was cut in the Hamp hole. This zone in trench 1 is about 200 feet southwest of and dips about 85° toward the Hamp hole.

The association of these radioactivity zones with a structural disturbance, Hicks Dome, suggests a common origin, whether the Dome be the result of an igneous intrusion at great depth or an incipient cryptovolcanic structure, as suggested by Brown.

The association of fluorite, which migrated upward along the breccia or fault zones, with the thorium and rare earths suggests a common origin. Although the fluorite and thorium and rare earths are both localized in the breccia, the evidence suggests that the thorium is not present as a substitution in the fluorite lattice; for example, X-ray work shows that no fluorite is in the most radioactive core sample.

Resources

A small quantity of low-grade material was found in a narrow vein. In order to complete the record, the following resource calculation is made for the narrow highly radioactive vein:

$$\frac{260 \text{ (length in feet)} \times 1 \text{ (width in feet)} \times 100 \text{ (depth in feet)}}{20 \text{ (cubic feet per ton)}}$$

= 1,300 short tons

0.4 percent thorium
2.0 percent combined rare earths
(Ce, La, Nd, Pr)

The resources are indicated for 50 feet below the trench bottom and inferred for an additional 50 feet. The lack of definite data in the drill holes precludes any further calculation.

Efficiency of Operations -- Competency of Operator

The bulldozing and diamond drilling operations were carried out in an efficient and satisfactory manner. The operator's representative has apparently had no experience in mining or in keeping related records, but on the whole, they are acceptable.

Expenditures

Bulldozing 11,700 cu. yds. at	$0.20	$ 2,340.00
Core drilling 405 ft. at	4.00	1,620.00
Surveying and mapping		250.00
41 chemical or spectrographic determinations		400.00
Total actual cost		$ 4,610.00

Total approved	$ 5,620.00
Total cost of project	4,610.00
Government's share of cost	3,457.50
Government's share unexpended	757.50

Value of production - None
Government royalty - None

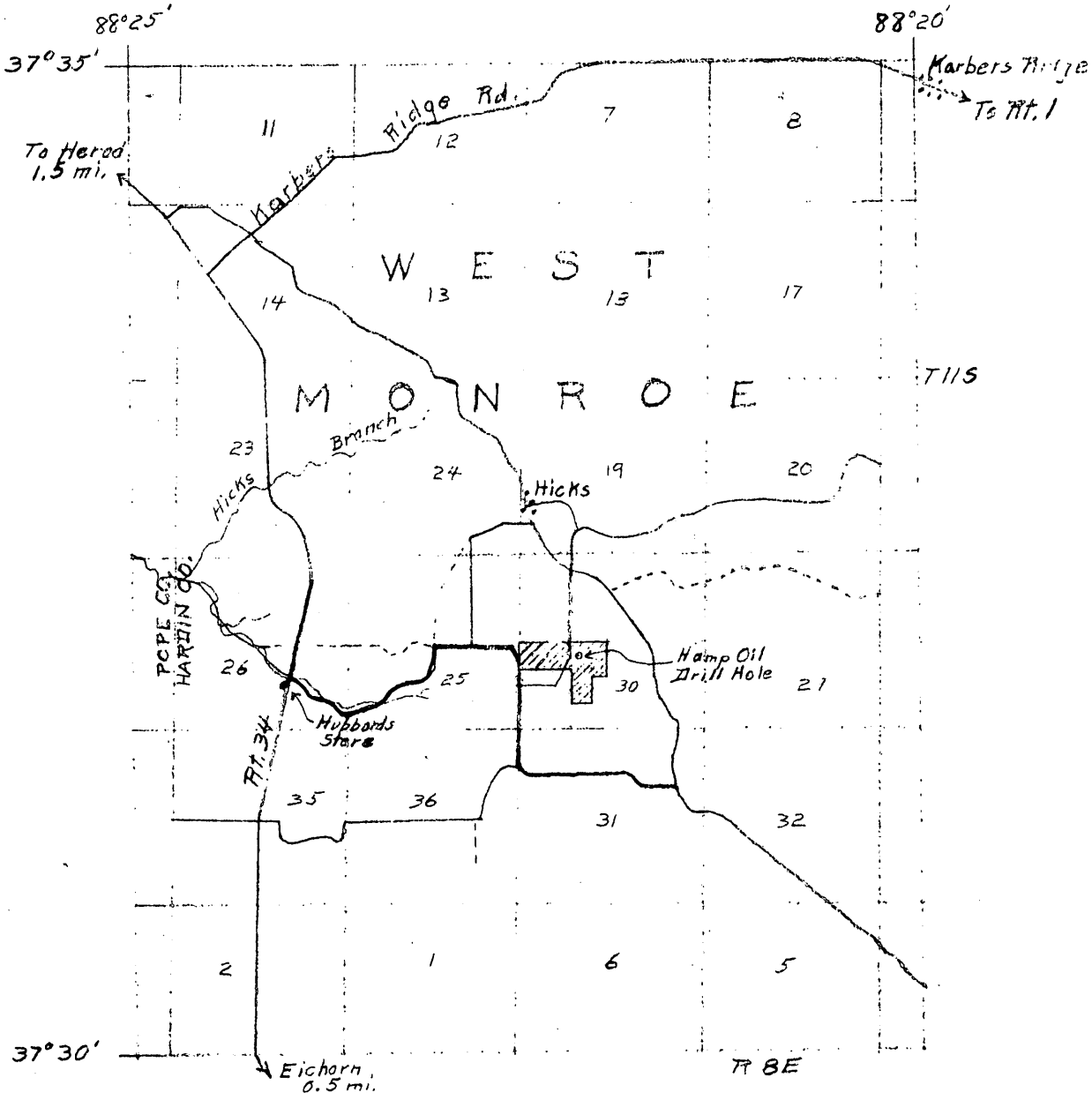
No equipment was purchased.

Robert D. Trace

Robert D. Trace, Geologist
U. S. Geological Survey

H. L. Burmeister

H. L. Burmeister, Engineer
U. S. Bureau of Mines



HAMP LEASE

DMEA 3855, CONTRACT Idm-E 914
HAMP LEASE, HICKS DOME, HARDIN CO. ILL.
STATE of ILLINOIS — EQUALITY QUAD.

0 miles 1

FIG. 1.

DMEA #3855
Idm-E914

SUMMARY OF HICK'S DOME SAMPLE ANALYSES

Analyst	Sample No.	Thor.	U_3O_8	Cb	Ta	Rare Earths	Zirc.	Lith.
C. O. Parker	11-A	.18 x	.048 x	Tr. x	Tr. x	.67 x	Tr. x	
"	11-B	.17 x	.02 x			.40 x		
"	12-A	.11 x						
"	12-B	Tr. x						
"	13-A	.19 x	.038 x			.84 x		
"	13-B	Tr. x	.096 x			Tr. x		
"	14-A	.14 x						
"	14-B	Tr. x						
"	15-A	.09 x				.38 x		
"	15-B	Tr. x				.15 x		
"	16-A	.21 x						
"	16-B	.12 x						
"	17-A	.47 x	.040 x			1.47 x		
"	17-B	.07 x				.32 x		
"	18-A	.17 x						
"	18-B	Tr. x						
"	19-G	.49 x	.084 x	Tr. x	Tr. x	1.65 x	Tr. x	Tr.
"	21-G	Tr. x				.12 x		
"	3-A	.13	.078	Tr.	Tr.	.58	Tr.	
Lindsay Chemical	1-A	.50				2.20		
"	19-G	1.0				3.0		
"	20-G	.60				3.1		
Vanadium Corp.	19-G	1.0 Est.	.06					

FIG. 2 a

Figure 2b
DMEA 3855

SEMIQUANTITATIVE SPECTROGRAPHIC ANALYSIS

Report No.	For	Date
TWS-2925	R. D. Trace	November 7, 1956

Lot No.	Spec. Lab. No.	Plate No.	Refer.
1639	2395	III-2183	TWP-3171 TWC-5127

Notation: Figures are reported to the nearest number in the series 10, 3, 1, .3 etc., in percent. Eighty percent of the reported results may be expected to agree with the results of quantitative methods. Symbols used are:

- \- = not looked for
- 0 = looked for but not detected (see attached table of sensitivities)
- M = major constituent - greater than 10%
- < with number = below number shown; here standard sensitivities do not apply

Samples from Hicks Dome, Illinois

Field No.	15A	15B		15A	15B
Lab. No.	148359	148360		148359	148360
Si	M	M	La	.3	.1
Al	1.0	1.0	Li	0	0
Fe	M	10	Lu	.001	.001
Mg	.03	.1	Mo	.001	.001
Ca	.1	.1	Nb	0	0
Na	0	0	Nd	.3	.1
K	0	0	Ni	0	.001
Ti	.3	.3	Os	0	0
P	1.0	.3	Pb	.03	.03
Mn	.03	.03	Pd	0	0
Ag	0	0	Pr	.03	.01
As	0	0	Pt	0	0
Au	0	0	Rb	0	0
B	.003	.003	Re	0	0
Ba	.03	.01	Rh	0	0
Be	.001	.0003	Ru	0	0
Bi	0	0	Sb	0	0
Cd	0	0	Sc	.003	.003
Ce	1.0	.3	Sn	.001	.001
Co	.001	.001	Sr	.1	.03
Cr	.001	.001	Sm	.003	0
Cs	0	0	Ta	0	0
Cu	.003	.003	Tb	0	0
Dy	.03	.01	Te	0	0
Er	.03	.03	Th	.1	.03
Eu	.003	0	Tl	0	0
F	-	-	Tm	0	0
Ga	0	0	U	.1	0
Gd	.1	.03	V	.01	.003
Ge	0	0	W	0	0
Hf	0	0	Y	.1	.1
Hg	0	0	Yb	.003	.003
Ho	0	0	Zn	0	0
In	0	0	Zr	.01	.01
Ir	0	0			

By Spectrographic Methods for AEC (Washington)
Katherine V. Hazel
Project Leader: Claude L. Waring

Liaison Officer
Atomic Energy Commission Program
Geochemistry and Petrology Branch

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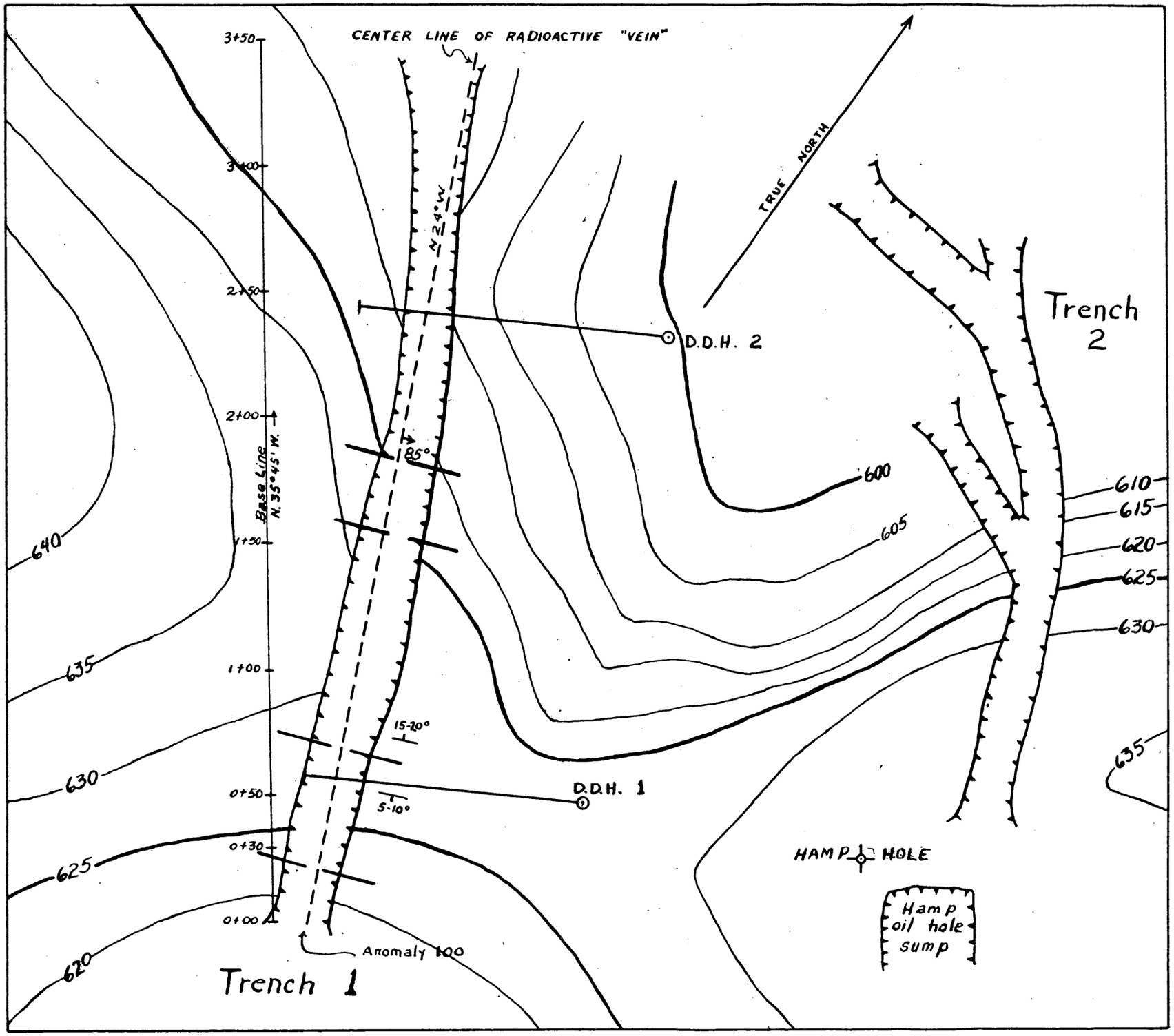

EXPLANATION

FAULT

15°

APPARENT STRIKE AND DIP OF BEDS

D.D.H.1

DIAMOND DRILL HOLE

TRENCH

BASE MAP MODIFIED AFTER MAP BY B. L. BAXTER

CONTOUR INTERVAL 5 FEET
DATUM IS APPROXIMATELY MEAN SEA LEVEL

0 25 50 100 FEET

SEPTEMBER 1956

(SEE FIGURE 8 FOR LOCATION OF TRENCH SAMPLES.)

Figure 3.--MAP OF PART OF REYNOLDS PROPERTY HICKS DOME, HARDIN COUNTY, ILLINOIS

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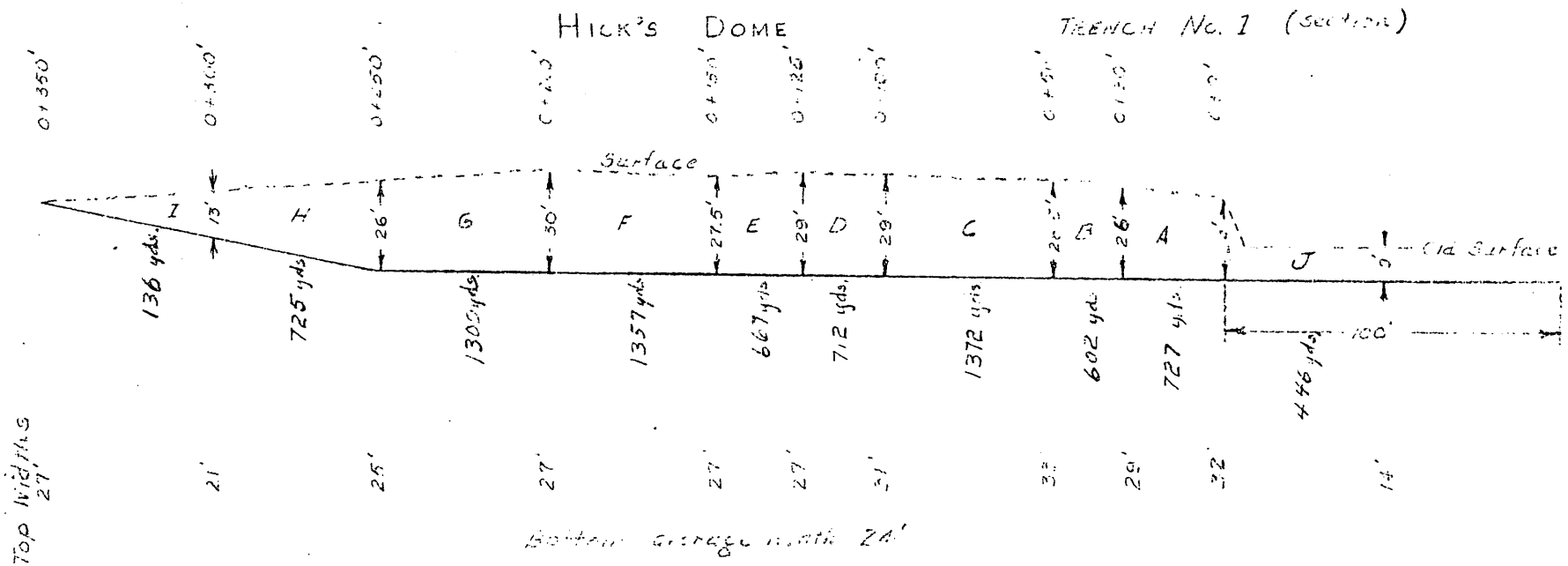

TOTAL CUBIC YARDAGE = 8044

HICK'S DOME

DMEA - 3855

TRENCH No. 1

MEASUREMENTS FOR CUBIC YARDS

0 INCHES 1

0 FEET 50'

7-1-58

FIG. 4

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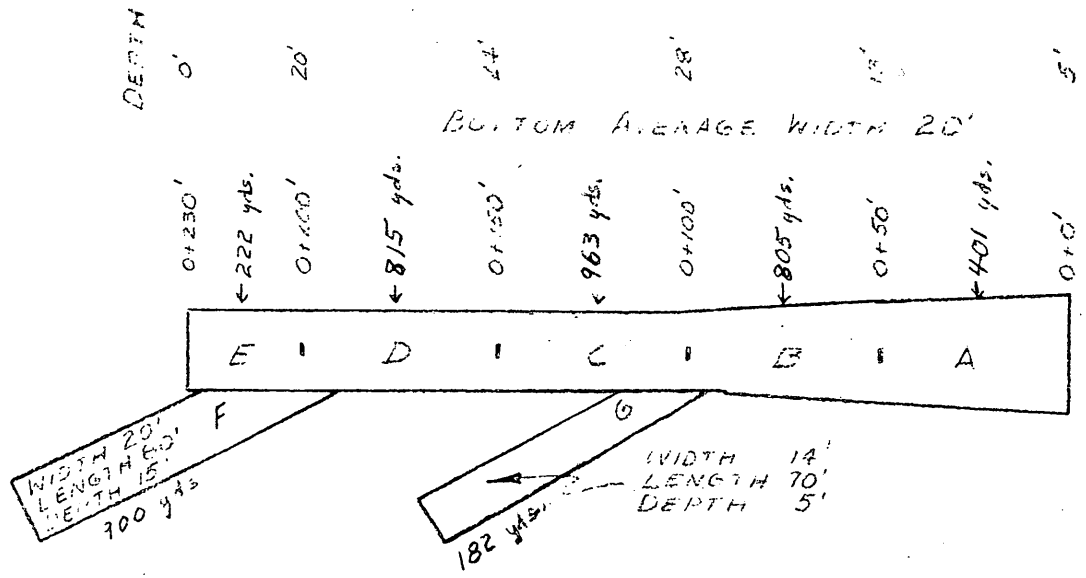
TRENCH No. 2 (Plan)



TOTAL CUBIC YARDAGE = 4288

INCHES DIGGE
DMEA - 3255
TRENCH No. 2
MEASUREMENTS FOR CUBIC YARDS

0 INCHES 1
0 FEET 50

T-255

FIG. 5

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Average of Determinations

Item	Number of Determinations	By	Trench No.	"A" or "B"	Chem. Thorium Percent	Chem. U_3O_8 Percent	Chem. Cb-Ta Percent	Spectrographic Rare earths Percent	Zr	Li
I	10	C. O. Parker	1	A	0.22					
II	8	C. O. Parker	1	A	0.15					
III	3	Lindsay Chemical	1	A	0.70					
IV	8	C. O. Parker	1	B	0.045					
V	6	C. O. Parker	1	A				0.93		
VI	4	C. O. Parker	1	B				0.22		
VII	3	C. O. Parker	1	A			Tr.		Tr.	Tr.
VIII	7	C. O. Parker	1	A&B		0.057				
IX	3	Lindsay Chemical	1	A				2.77		
X	1	C. O. Parker	2	A	Tr.	0.006		0.12		

Explanation: ← 2' → 1' ← 2' → Refer to Fig. and Table

"A" Composite "B"

II - Eliminates 2 high assays included in I, (17A cut sample and 19G grab sample).
III - Grab Samples 19G and 20G; also cut sample 1A.
V - Includes grab sample 19G.
IX - Includes grab samples 19G and 20G; also cut sample 1A.

~~Table~~ FIG-6

SUMMARY OF HICK'S DOME SAMPLE ANALYSIS

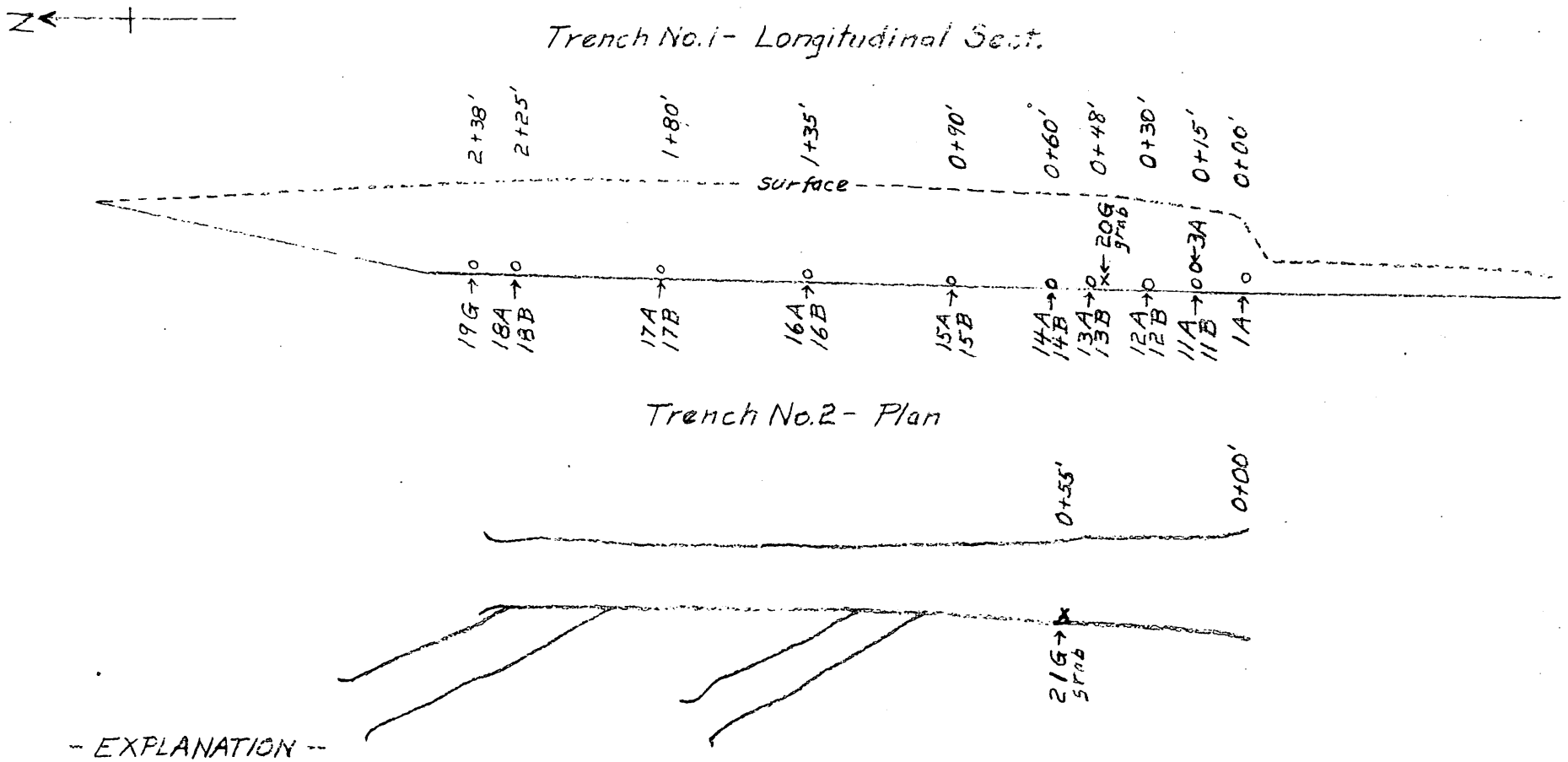
Analyst	Sample Number	Thor.	U_3O_8	Cb	Ta	Rare Earths	Zirc.	Lith.	DMEA Cost
C. O. Parker	11-A	.18 $10.	.048 $5.	Tr. $20.	Tr.	.67 $10.	Tr.		$45.00
"	11-B	.17 $10.	.02 $5.			.40 $10.			25.00
"	12-A	.11 $10.							10.00
"	12-B	Tr. $10.							10.00
"	13-A	.19 $10.	.038 $5.			.84 $10.			25.00
"	13-B	Tr. $10.	.096 $5.			Tr. $10.			25.00
"	14-A	.14 $10.							10.00
"	14-B	.09 $10.				.38 $10.			20.00
"	15-A	.09 $10.				.38 $10.			20.00
"	15-B	Tr. $10.				.15 $10.			20.00
"	16-A	.21 $10.							10.00
"	16-B	.12 $10.							10.00
"	17-A	.47 $10.	.040 $5.			1.47 $10.			25.00
"	17-B	.07 $10.				.32 $10.			20.00
"	18-A	.17 $10.							10.00
"	18-B	Tr. $10.							10.00
" Grab	19-G	.49 $10.	.084 $5.	Tr. $20.	Tr.	1.65 $10.	Tr.	Tr.	45.00
" Trench 2	21-G	Tr. $10.	.006 $5.			.12 $10.			25.00
"	3-A	.13 $10.	.078 $5.	Tr. $20.	Tr.	.58 $10.	Tr.		45.00
Lindsay Chemical	1-A	.50				2.20			
" Grab	19-G	1.0				3.0			
" Grab	20-G	.60				3.1			
Vanadium Corp.	19-G Grab	1.0 Est.	.06						

Total DMEA Sample Cost $400.00

Note: Zirconia & Lithium analyses cost to be borne by W. G. Reynolds

FIG. 7

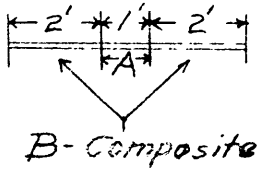
SAMPLE LOCATIONS



- EXPLANATION --

X - Grab Sample

o - Cut Sample in floor thus



WM. G. REYNOLDS
DMEA 3855 - CONTRACT E 914
HICKS DOME - HARDIN CO. ILL.

0 inches 1
0 feet 50

FIG.-8

Figure 9a.—DESCRIPTION OF HICKS DOME D.D.H. 1 AND 2
(See also parts b and c.)

Both D.D.H. 1 and 2 cut dolomitic limestone of Devonian age which in places contains so many fine quartz grains that it is called chert, and several limestone-chert breccia zones which contain traces of purple fluorite and white calcite and, in places, are slightly radioactive.

No differentiation into lithologic units could be made in either hole; therefore, the following description applies to both holes. The specific location of breccia zones, cavities, radioactivity anomalies, and traces of fluorite is shown on parts b and c.

Country rock in D.D.H. 1 and 2: Limestone, medium to dark gray, fine grained, with abundant rhombohedrons of dolomite; and chert, light brown and fine grained. The chert contains from 80 to 90 percent of fine quartz grains and no more than 10 to 20 percent of interstitial carbonate. About 1/2 to 2/3 of the country rock is dolomitic limestone and the remaining 1/3 to 1/2 is chert.

The chert occurs in layers that range from less than an inch to over a foot thick. The boundaries between the chert and the limestone are sharp, but irregular and wavy rather than straight. The chert layers contain abundant irregular-shaped remnants of dolomitic limestone.

Breccia zones in D.D.H. 1 and 2: The breccia zones consist of limestone and chert that have been shattered into fragments as large as an inch in diameter, with interstitial fillings and veinlets of purple fluorite and white calcite. The radioactivity is associated with the breccia, either in narrow cavernous and leached zones that contain clay-sized brown material, or in narrow dark brown zones that appear to be partly altered.

Laboratory determination of the percent eU of several samples follows:

D.D.H. 1	142.4-142.8	0.002
	156.0-156.1	.013
	179.0-180.0	.009

D.D.H. 2	100.6-100.9	0.006
	101.8-102.1	.007
	122.9-123.1	.009
	127.9-128.0	.018
	139.0-139.4	.003

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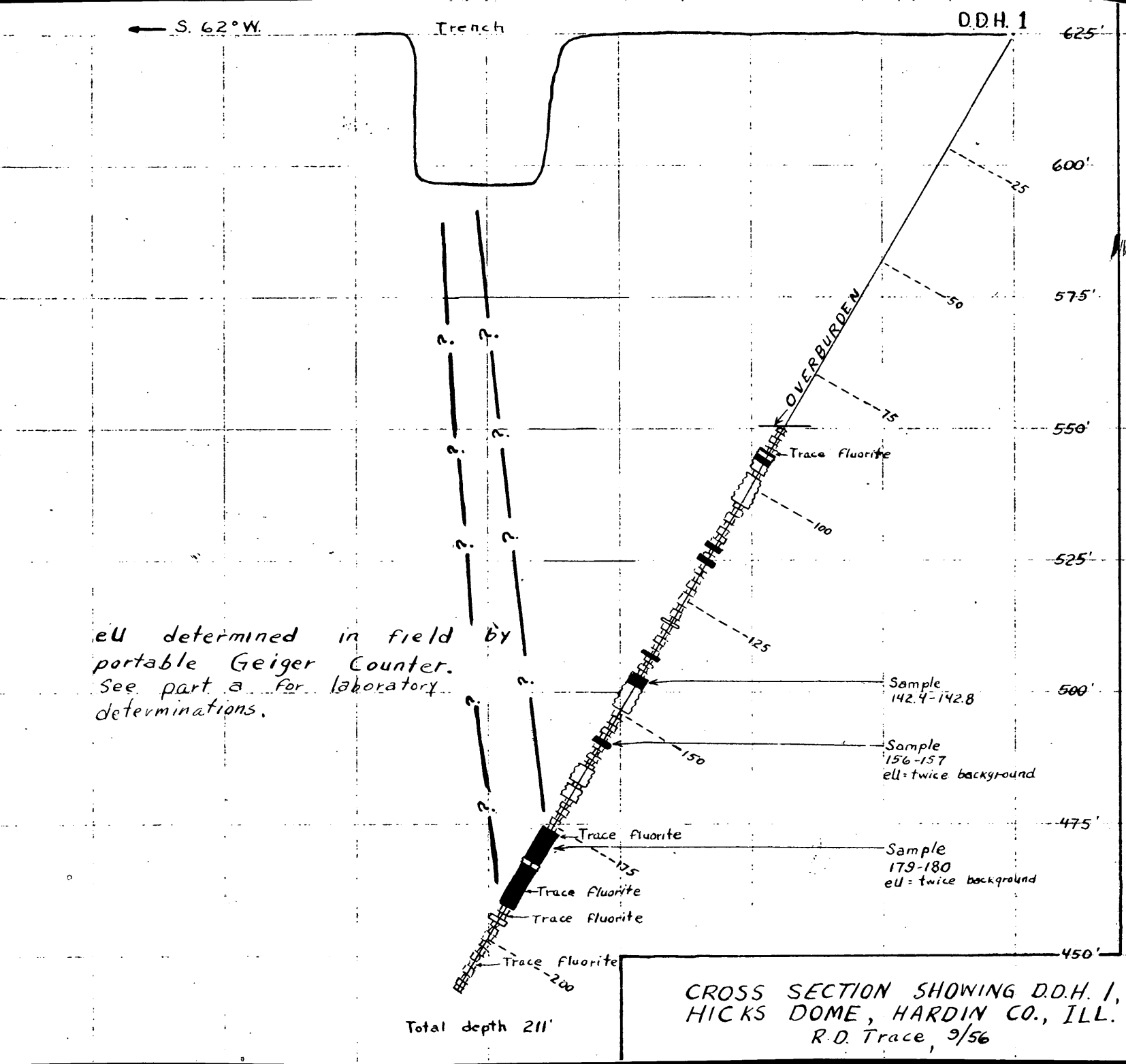


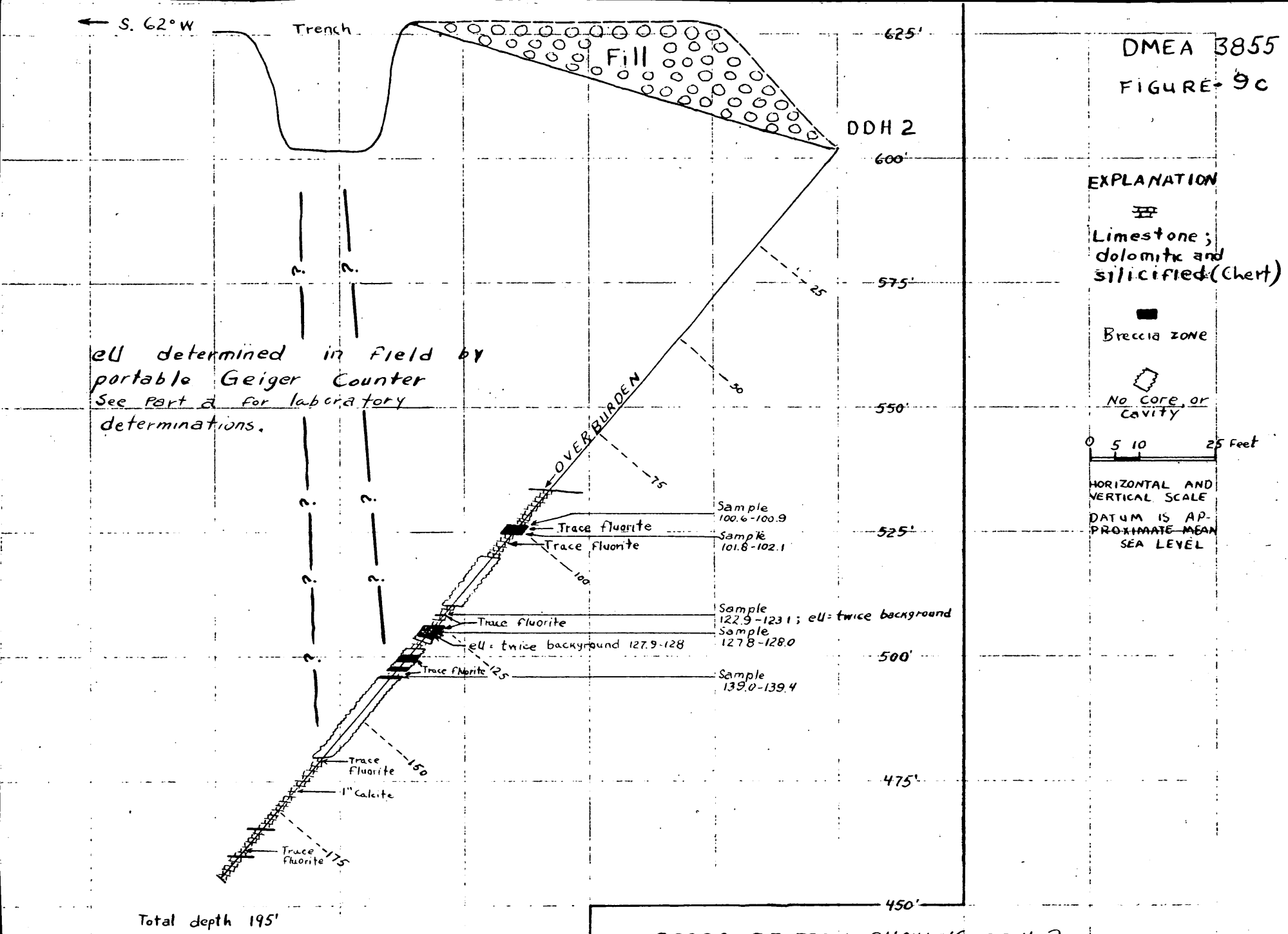
DMEA 3855

FIGURE-9b

CROSS SECTION SHOWING D.D.H. 1, HICKS DOME, HARDIN CO., ILL.
R.D. Trace, 9/56

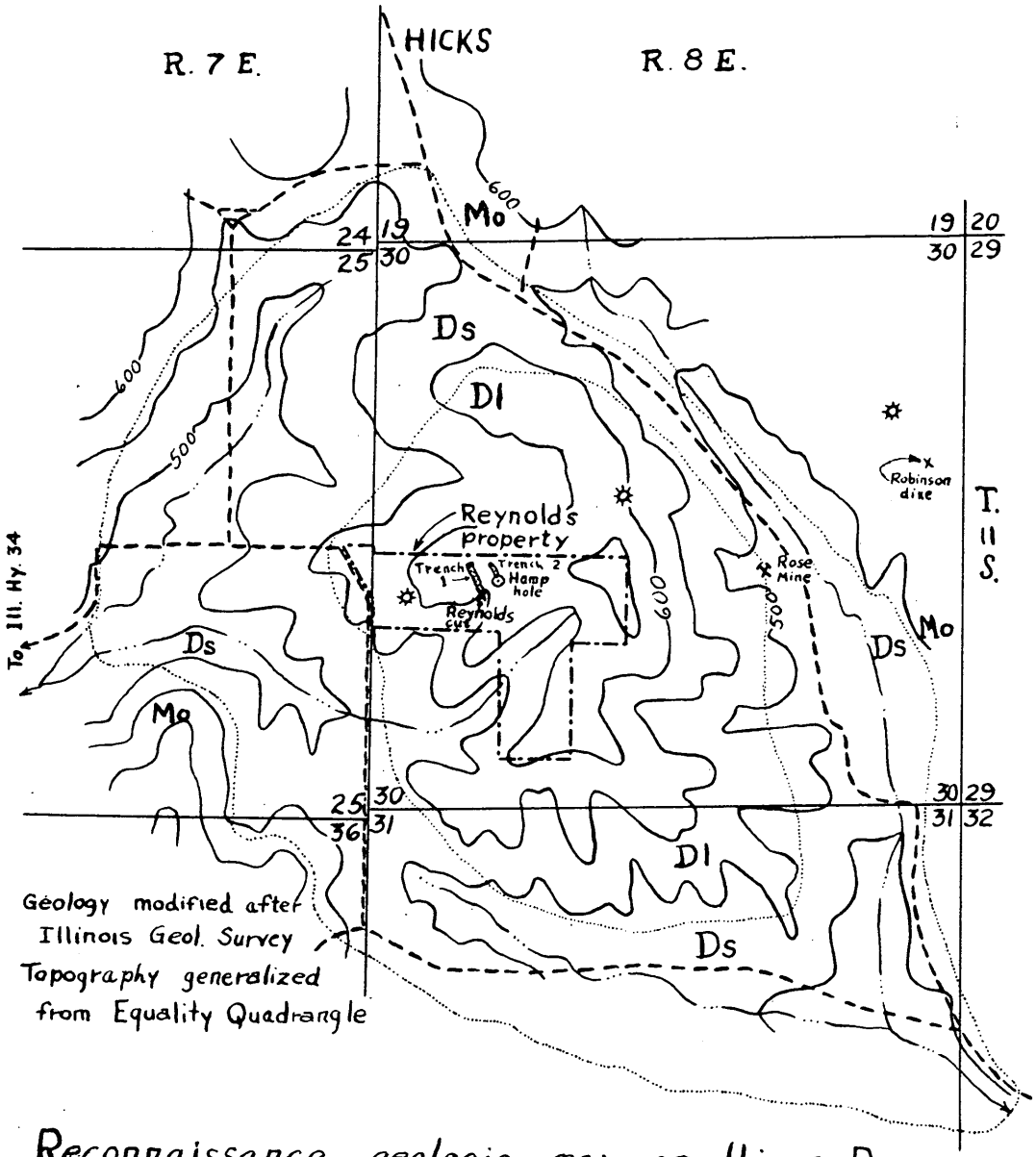
DMEA 3855

FIGURE 9c



CROSS SECTION SHOWING D.D.H. 2
HICKS DOME, HARDIN CO., ILL.
R D Trace 9/56

Figure 10
DMEA 3855



Reconnaissance geologic map of Hicks Dome area
Hardin County, Illinois

EXPLANATION

Mo
Mississippian, Osage fm.

Ds
Devonian shale

Dl
Devonian limestone

Geologic contact (approximate)

Breccia

x
Pit or open cut

Fluorspar mine

Graded road

0 ¼ ½ 1 mile

Contour interval 50 feet
Datum is mean sea level

(See Figure 3 for detailed map of project area.)

R.D.T.
1-1-57 10-16-55

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Trench No. 1

Photograph by
U. S. Dept. of the Interior
Bureau of Mines
Minerals Technology Division
College Park, Maryland

Neg. No. H-1401-CP

Date _____

If this picture is used for
publication, please credit
the Bureau of Mines.

Trench No. 2

Photograph by
U. S. Dept. of the Interior
Bureau of Mines
Minerals Technology Division
College Park, Maryland

CP Neg. No. H-1399-CP

Date _____

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Field Team Report on Examination of Property
by
G. L. Kelmann and Robert L. Trace 1/

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DMEA Docket No. 3055 - (Uranium, thorium and rare earth minerals)

Applicant: William C. Reynolds
Hodgeate Road, Anchorage, Kentucky

Property: Map Lease - Hicks Dome
Hardin County, Illinois

Summary:

The objective of this application is to enhance the Nation's reserves in these various critical and strategic materials. For the past four months considerable activity and excitement has been rampant in this territory, brought about by the many high readings on Geiger counters and scintillators, many at 200 - 400 times the background and from a good sized area surrounding that geologic nonconformity, known as Hicks Dome. The Illinois Geological Survey has six men working this area for a period of six weeks and analyzed some 170 samples. Numerous geologists and engineers, representing many of the large mining companies, have all deeply interested in uranium and other radioactive materials, came here for examinations. Only a few of the many samples taken from this area by the Illinois Geological Survey and numerous prospectors have indicated commercial grade uranium to be present.

The application was referred to the Field Team for an on-site examination. All factual data were collected from the Illinois Geological Survey, the applicant and other parties interested in the territory. The Map lease comprises the crest area of Hicks Dome. The area was traversed with a Geiger counter and a scintillator, the best anomaly appeared to be a N.20°-30°W.trending vein (anomaly "100"), approximately 19 feet thick, exposed in a vertical wall at the north end of a bulldozer trench. Five

1/ O. L. Kelmann, engineer, Bureau of Mines and
Robert L. Trace, geologist, Geological Survey.

channel samples were cut across this vein from west to east, breaks being made on slight apparent lithological differences. Another sample was taken about four feet east of this vein.

These six samples were split four ways and analyzed by four different laboratories: (1) Bureau of Mines, College Park, Md., (2) Bureau of Mines, Tuscaloosa, Ala., (3) U.S.N.O.S. Naval Gun Factory, Washington, D. C. (4) Vanadium Corporation of America, Durango, Colo. The results follow:

Sample No.	Sample Length in.	Microroentgen Reading*	College Park eU	College Park Th	Tuscaloosa eU	Gun Factory eU	Gun Factory U	Vanadium Corporation U_3O_8
1	19	450	0.032	0.15	0.036	0.035	0.004	0.05
2	17	600	< 0.005	0.02	0.004	0.003	0.001	0.03
3	16	900	0.051	0.45	0.11	0.054	0.008	0.13
4	19	600	0.020	0.10	0.025	0.022	0.003	0.06
5	37	500	0.033	0.15	0.039	0.036	0.004	0.02
6	16	600	0.044	0.20	0.050	0.042	0.004	0.07

* background count 13 microroentgens

The Bureau of Mines at College Park and the Geological Survey report as much as 2-2.5% combined rare earths and thorium is present. (see table 1 - appendix)

The average microroentgen count on a scintillator (model 111B) across the vein was approximately 700 against a background count of 13 microroentgens. The work program for the exploration, as amended by the applicant's representative, Mr. Bruce Baxter, and agreed to as the most operable procedure by the Field Team representatives, is to test this structure by removing the overburden to the northeast to determine the extent of this vein and then to trench along the apparent trend down to a depth of 30 feet.

It appears that the anomaly might get stronger with greater depth. Another good anomaly was found at the site of the sludge pond from the Heap oil hole. No samples were taken here on account of the bulldozer cut here being full of water. The amended work program would also include a north-south 50 foot long bulldozer trench to a depth of about 30 feet on this anomaly. Test diamond core drilling to a maximum of 100 feet has also been proposed.

Conclusions:

Most of the factual data collected appear to indicate that this deposit is not too encouraging from a viewpoint of uranium, but the occurrence of thorium, associated with numerous rare earth minerals, would be worthy of exploration.

Recommendations:

The Field Team representatives recommend that the amended work program consisting of two bulldozer trenches (1) on anomaly "AA" and (2) on the Heap sludge pond anomaly, be approved, (3) test diamond core drilling, and (4) necessary sampling, analyses, and mapping.

Time Spent on the Property:

The on-site examination took place on Saturday, July 30, 1955. Conferences were held on Friday, July 29 and Saturday, July 30. The Field Team representatives, Robert L. Truse, U.S.Geological Survey and G. L. Neumann, Bureau of Mines, were accompanied on the examination by Mr. Bruce Baxter, applicant's representative, Mr. N. L.Ostrom, Illinois Geological Survey, and Mr. V. J. Lynch, Bureau of Mines Member of DMA Field Team. Mr. Ostrom did not participate in the conferences.

Name and Location of Property:

The Hemp lease, comprising 51.5 acres, is located sec 1 and 2, on the crest of Hicks Dome in Hardin County, Illinois. It is approximately 10 miles from the towns of Cosiclare or Elizabethtown via Illinois Highways 34 and 146, a county road to and around Hicks Dome and a bulldozer trail to the leases. This lease consists of the N½ of the NW¼ of the SW¼, (20 ac); the N½ of the NE¼ of the SW¼, (20 ac); the NW¼ of the SE¼ of the SW¼, (10 ac); the western 3/4 of the NE¼ of the NE¼ of the SW¼ (10 ac); a small fraction of the NW side of the SW¼ of the NE¼ of the SW¼ of the SW¼ (6 ac); all of Section 30, Township 11 S, Range 7 E of the 3rd principal meridian.

Also a triangular plot in the NE Cor. of the NE¼ of the SE¼ (1½ acres) of Section 25, Township 11 S, Range 7 E of the 3rd principal meridian.

Condition and Seasonal Accessibility of road to Property:

Illinois Highways 34 and 146 are good all-weather roads. The county road to Hicks Dome is a good gravel all-weather road, the road to the crest of the Dome is clay and is not usable in wet weather.

Competency of Applicant:

The applicant is a highly successful operator in the mineral industry and employs men of high caliber for all operations. He is quite capable to furnish his share of the explorational costs.

Property Rights:

A copy of the lease and assignment of the lease to the applicant is included in the application and appears to be in good form. If the owner's consent to lease cannot be obtained the applicant is prepared to procure waiver to this document by a guarantee satisfactory to the Government for the repayment of any funds provided by the Government in this explorational program, providing that such explorational program is certified as a discovery or development and production is realized within the allotted time period.

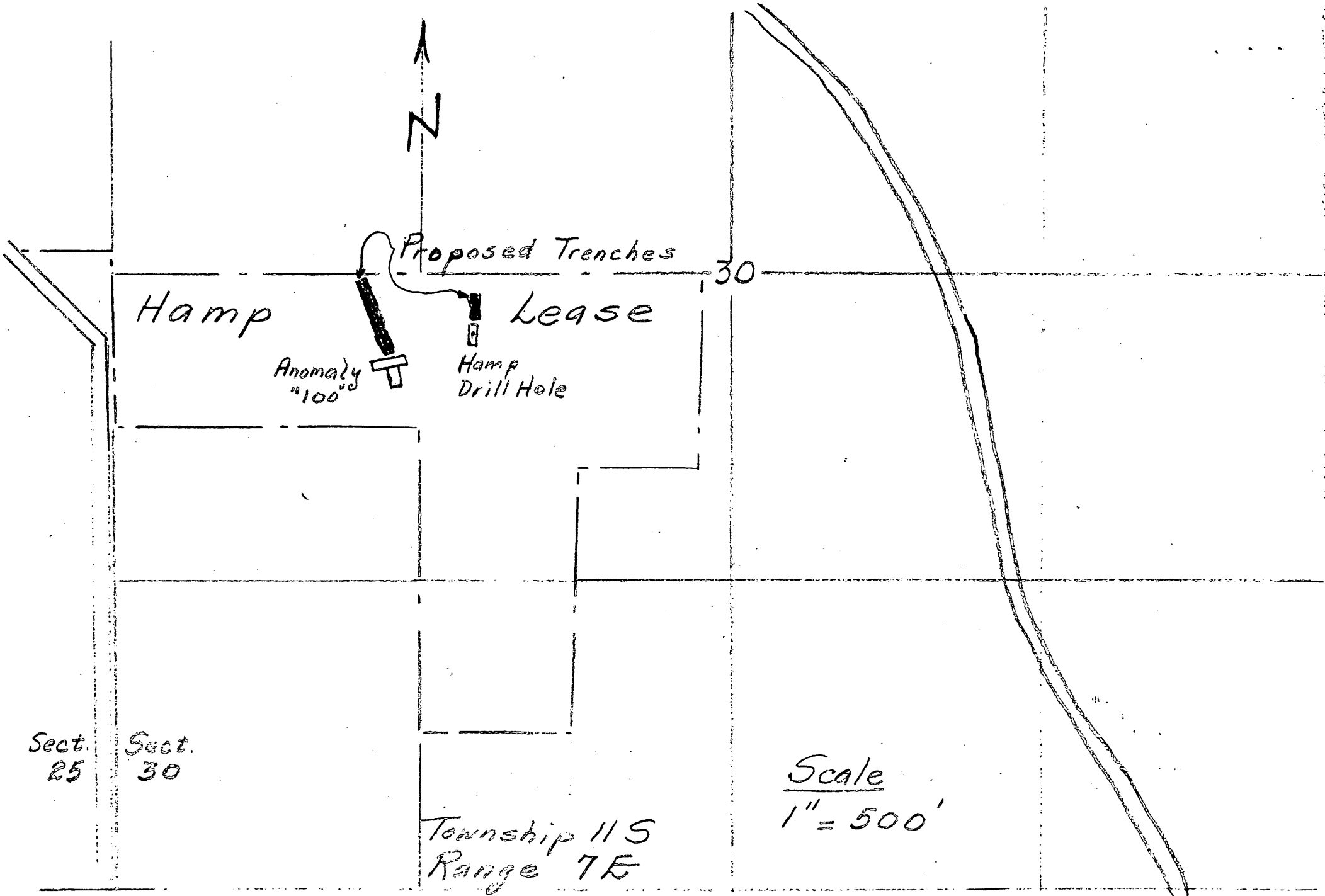

Figure 1. PLAN OF HAMP LEASE - HICK'S DOME
Hardin Co[redacted] Illinois

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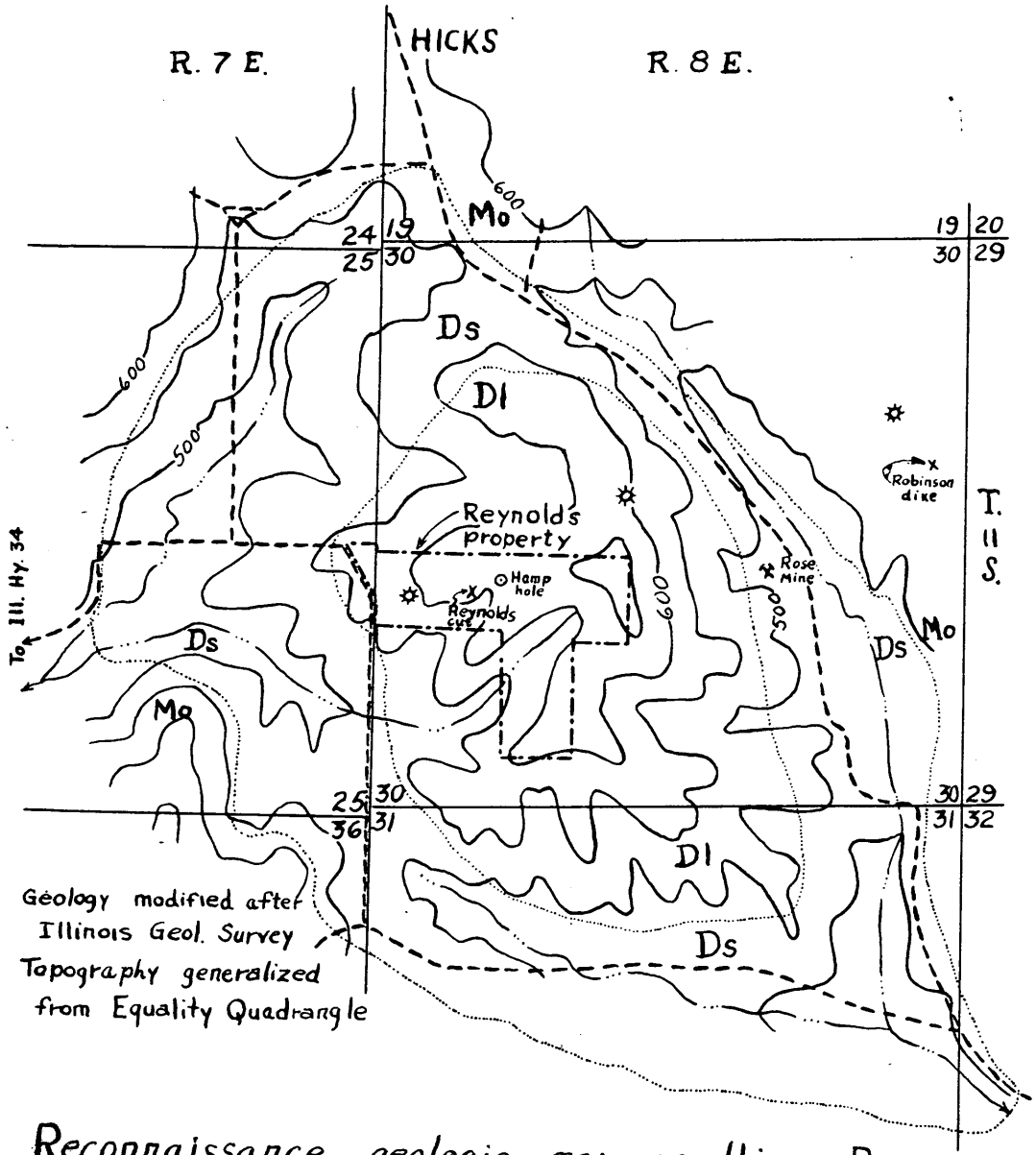
Figure 2
DMEA 3855



Reconnaissance geologic map of Hicks Dome area
Hardin County, Illinois

EXPLANATION

Mo
Mississippian, Osage fm.

Ds
Devonian shale

Dl
Devonian limestone

Geologic contact (approximate)

Breccia

x
Pit or open cut

Fluorspar mine

Graded road

0 ¼ ½ 1 mile

Contour interval 50 feet
Datum is mean sea level

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Description of Property:

The area covered by the Hamp lease is primarily the crest of Hicks Dome (fig.3). Part of it is in cultivation. It is fairly flat and only sparsely timbered. The main exploration (see maps included with application) that has been performed to date, amounts to: (1) the Hamp oil well 2,944 feet); (2) two bulldozer cuts, Hamp sludge pond (50 x 20 x 10') and anomaly "100", a T-shaped cut (50 x 20 x 20') and (50 x 20 x 20', [illegible]); (3) one vertical diamond core hole (70 feet); (4) several hand-dug pits. There are no mine workings.

Geology:

General - The applicant's property is near the center of Hicks Dome, which is in the northern part of the Illinois-Kentucky fluorspar district. The name Hicks Dome refers to a small domal uplift in northwestern Hardin County, southern Illinois. The geology of the area is described in the following:

1. Weller, J. Marvin, et al., 1952, Geology of the fluorspar deposits of Illinois, Ill. Geol. Survey, Bull.76.
2. Brown, J.S. et al., 1953, Exploration well on Hicks Dome, Hardin County, Illinois, Econ.Geol. Vol. 48, No. 8.
3. Bradbury, J.C., Ostrom, M.E., and McVicker, [illegible], 1955, Preliminary report on uranium in Hardin County, Illinois, Ill. State Geol. Survey Circular 200 (preprint).

Item 1 describes the geology of the Illinois part of the fluorspar district, but does not mention any radioactivity.

Item 2 describes the results of the 2,944-foot Hamp oil test hole in the center of the dome and on the Reynolds property (fig.2). In summary, the hole penetrated Devonian, Silurian, and Ordovician sediments from the surface to 1,605 feet; from 1,605 to 2,944 the hole penetrated a breccia zone which contained traces of fluorite, calcite, quartz, pyrite, sphalerite, galena, and thorium and several rare-earth elements. Equivalent uranium

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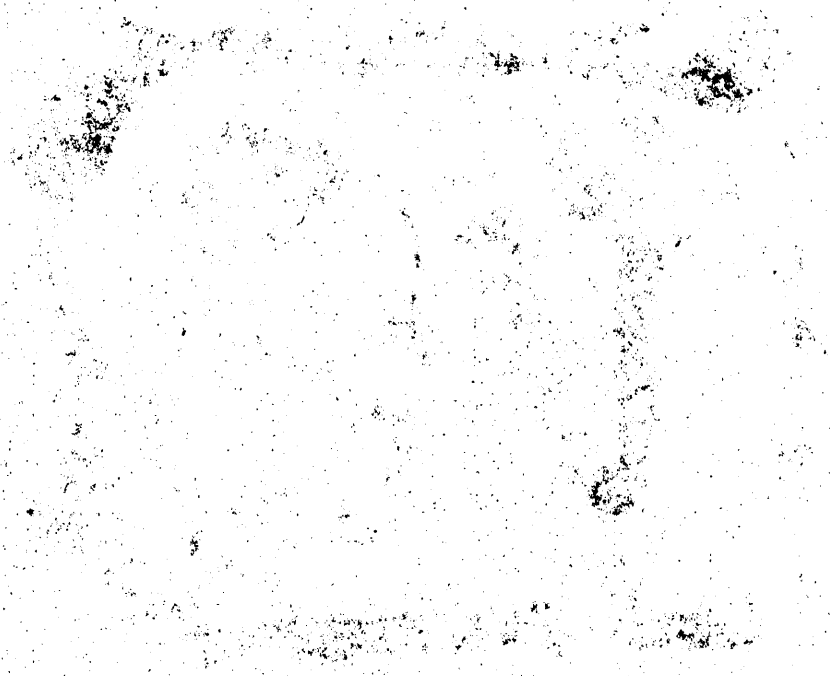

Figure 3 - Hicks Dome looking east.

chemical uranium, and cesium chloride, and spectrographic analyses of eight samples taken by drown from the hole are given in table 1 of this DMEA field examination report.

Item 3 summarizes the results of a study of the uranium possibilities of the Dome area by the Illinois Geological Survey during early 1955. Much of the data given in this DMEA field examination report is taken from the Illinois Survey's work. Item 3 is an excellent summary of the area and its uranium possibilities. The abstract of item 3 follows:

> Hick Dome in Martin County, Ill., is an eroded structural dome whose specific mode of formation is not clear. Associated with it are explosion breccias and peridotite dikes. The central part of the dome is an area of about 1½ square miles underlain by rocks of Devonian-New Albany age, principally limestone and chert bordered by black shale. The bedrock in the central areas of the dome, as well as in other adjacent areas is covered by red and yellow clays believed to be a residuum resulting from the leaching of cherty Devonian limestone. Chert breccias, cemented by secondary silica, also are present.
>
> Tests of about 200 samples taken from the dome and throughout the county suggest that the residual clays and breccias within the Devonian-New Albany area of the dome are generally more radioactive than samples elsewhere, though there are some exceptions. Samples of fluorspar, silica, and lead ores, and concentrates from these ores have little or no radioactivity as measured by a laboratory Geiger counter. Eight determinations made by chemical procedure on 25 samples having some of the higher uranium equivalent values were all lower than the uranium equivalent values. All the samples analyzed for U_3O_8 contained less of this compound than the minimum of 0.1 percent for which prices are quoted by the Atomic Energy Commission.

Mr. L. P. Barrett of the Atomic Energy Commission visited the area in March 1955 (before the localized high radioactivity occurrence, anomaly "100", had been uncovered in the Reynolds cut), and wrote an administrative report on the area. A copy of this report was obtained through Mr. J. O. Hosted of the Commission. Mr. Barrett's conclusion follows:

The radioactivity in the Devonian chert and red clay on the apex of Hicks Dome is rather uniform and moderate averaging .09 mr/hr. It seems to be the result of mass effect of the red clay. No areas of high count were noted and the samples, when separated from the mass background, gave only slight counts on the scintillometer.

However, very little of the surface area of the Devonian sediments in Section 25, 30 or 31 is exposed for sampling or radioactive tests with the scintillometer. Therefore, the limited exposures sampled may not be a reliable index of the radioactivity of the Devonian rocks as a whole.

The center of Hicks Dome is underlain by cherty limestone and shale of Devonian age, dipping from 100 to 1,000 feet per mile (Fig.2). The shale is well exposed in several places, but only clay and chert are exposed in the area underlain by limestone. Mississippian and Pennsylvanian limestone, sandstone, and shale crop out in a circular pattern around the Devonian rocks, except to the southeast of the Dome where northeast-trending faults break the circular continuity. (See Ill. Geol. Survey, Bull. 70) Lamprophyre or peridotite dikes occur throughout the Illinois-Kentucky fluorspar district; one of these, the Robinson dike, is exposed in a trench about half a mile northeast of the Reynolds property (Fig.2). Chert breccias that have been ascribed to explosive igneous activity are present in the area. Spectrographic analyses were made of both the Robinson dike and a chert breccia (Fig.2) from the Reynolds property (Table 1, Reynolds 8,10).

Faults that trend northeast are common in the Mississippian and Pennsylvanian rocks surrounding the Dome, but because of the lack of bedrock exposures in the center of the Dome, it is not known whether the faults extend through the Devonian rocks. Slickensides have been reported by the Illinois Geological Survey, but according to that Survey "it is believed that such faults as may be present are small and of limited extent."

The forces that produced Mexia Dome and also the faulting in the Fluorspar District are incompletely known. The forces that produced the dome may be related to the forces that produced the numerous faults in the Fluorspar District. Perhaps the Dome reflects a deep igneous intrusion, possibly accompanied by buried explosive activity. The origin of the dome is more than an academic question, as the general localization of potential ore minerals might be predicted if the origin of the dome were known.

The potential ore found in the center of the dome is thorium and rare earths. According to chemical analyses the uranium found so far is extremely low in grade. Radioactivity analyses are as high as 0.11 percent eU but the highest government chemical analysis for uranium is .006 percent U (table 1, Reynolds 3). The radioactivity in the samples taken by the government representatives, and the samples from the deep hole, is caused by thorium. The writer cannot explain the discrepancies in the chemical uranium values of the samples designated Reynolds 1-6, as analyzed by the Vanadium Corporation of America and the USGS (table 1).

According to spectrographic analyses, from about 0.1 to 1.0 percent each of thorium, cerium, lanthanum, yttrium, and neodymium are present. Lesser quantities of other rare earths and niobium also are present. The writer has been unable to isolate or identify the rare earth and thorium-bearing mineral(s) in either the surface samples taken or in the eight samples from the deep oil test hole. The thorium and rare earths were concentrated, however, by using methylene iodide (specific gravity 3.3). The combined rare earth and thorium content of sample Reynolds 3 (table 1) was raised from 2-2.5 to about 7 percent.

The origin of the potential ore minerals is unknown. Two possibilities have been suggested: (1) the mineralization is related to the igneous activity that produced the lamprophyre dikes, the chert (explosion ?) breccias, and possibly the fluorspar deposits or (2) the minerals may have been leached from Devonian shale and deposited in fissures or sink holes in the underlying Devonian limestone. The Devonian shale is slightly radioactive and probably overlaid the entire area prior to the doming. In Tennessee, Devonian shale is radioactive; also about 12 to 20 miles north of the dome, thin beds of black shale that overlie Pennsylvanian coal beds, contain radioactivity as high as 0.018 percent eU. (See Patterson, S. H., 1955, Radioactivity of some coals and shales in southern Illinois, U.S. Geol. Survey TEI-660, unpublished report.)

At present, most of the known facts suggest that the mineralization is associated with the igneous activity. Fluorite, and thorium, and rare-earth elements are present in the breccia found in the Hemp Oil test hole (table 1). Spectrographic analysis of the Robinson dike also showed several rare earths. These rare earths may be in the mineral perovskite (a calcium titanite which may contain small quantities of rare earths), which is known to occur in many of the dikes of the area. Significant perhaps is the fact that the rare-earth content of the Robinson dike near the Dome is considerably higher than the rare-earth content of a lamprophyre dike near Marion, Kentucky (table 1, Kentucky 7), some 20 miles southeast of the Dome.

The association of rare earths and fluorite, as noted in the Hemp Oil test hole, is not uncommon. According to Allen (Allen, Robert D., 1952, Variations in chemical and physical properties of fluorite, the American Min., vol. 37, p. 910-930) minor quantities of yttrium, lanthanum, europium, and ytterbium are known to be present in the fluorite lattice. The six

samples also took from the Illinois-Kentucky district contained little if any of the rare earths. None of these six samples, however, were taken from near the Lone.

Reynolds property - The highest radioactivity occurrence in the Lone area is in the Reynolds cut at anomaly "100" (Fig. 1 and 2, table 1 - Reynolds 1-c). The sludge pond pit at the site of the deep oil test hole also contains scattered 1- to 2-foot areas of high radioactivity along its edges, but the pit was filled with water and no samples were taken. The proposed work is to sample and explore the surface continuity and depths of the radioactivity occurrences in these open cuts.

The Reynolds cut is on the side of a small hill, about 200 feet west-southwest of the site of the sludge pond pit and deep oil test hole. The cut is about 20 feet deep where samples Reynolds 1-c were taken on the vertical face of the uphill side (Figs. 2 and 3). Except the chert, all of the material exposed in the cut is highly weathered. A highly radioactive "vein" of alternating yellow clay zones and yellow clay and chert beds or fragments is present in the uphill face of the cut. The "vein" is about 14 feet wide, trends from N.20°-30°W., and dips 60-65° northeast. A "horse" of essentially barren material 4 feet wide occurs within the "vein" near the northeast wall (Fig. 3). Both the southwest and northeast wall of the "vein" is primarily red clay and chert, is only slightly radioactive, and contains significantly lesser quantities of rare earths than the "vein". (In table 1, compare Reynolds 9 with Reynolds 1-c.)

Within the highly radioactive yellow clay "vein", some of the chert occurs in mostly vertical beds as much as a foot wide. In the red clay "wall" zones, no vertical beds of chert were noted; some of the chert appears to occur in horizontal beds, although mostly it occurs as pebbles and boulders in random fashion.

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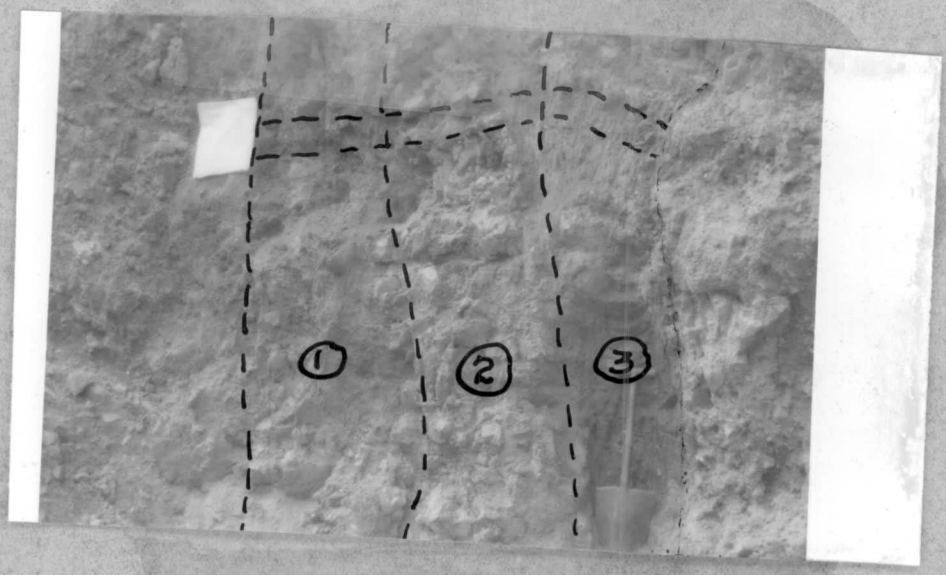


Figure 4 - Reynold's Cut, "Anomaly 100". Looking northwest and showing sample locations

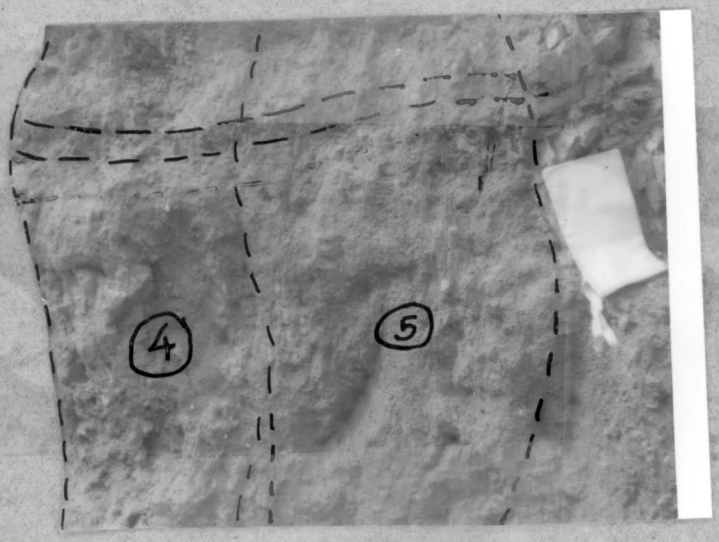
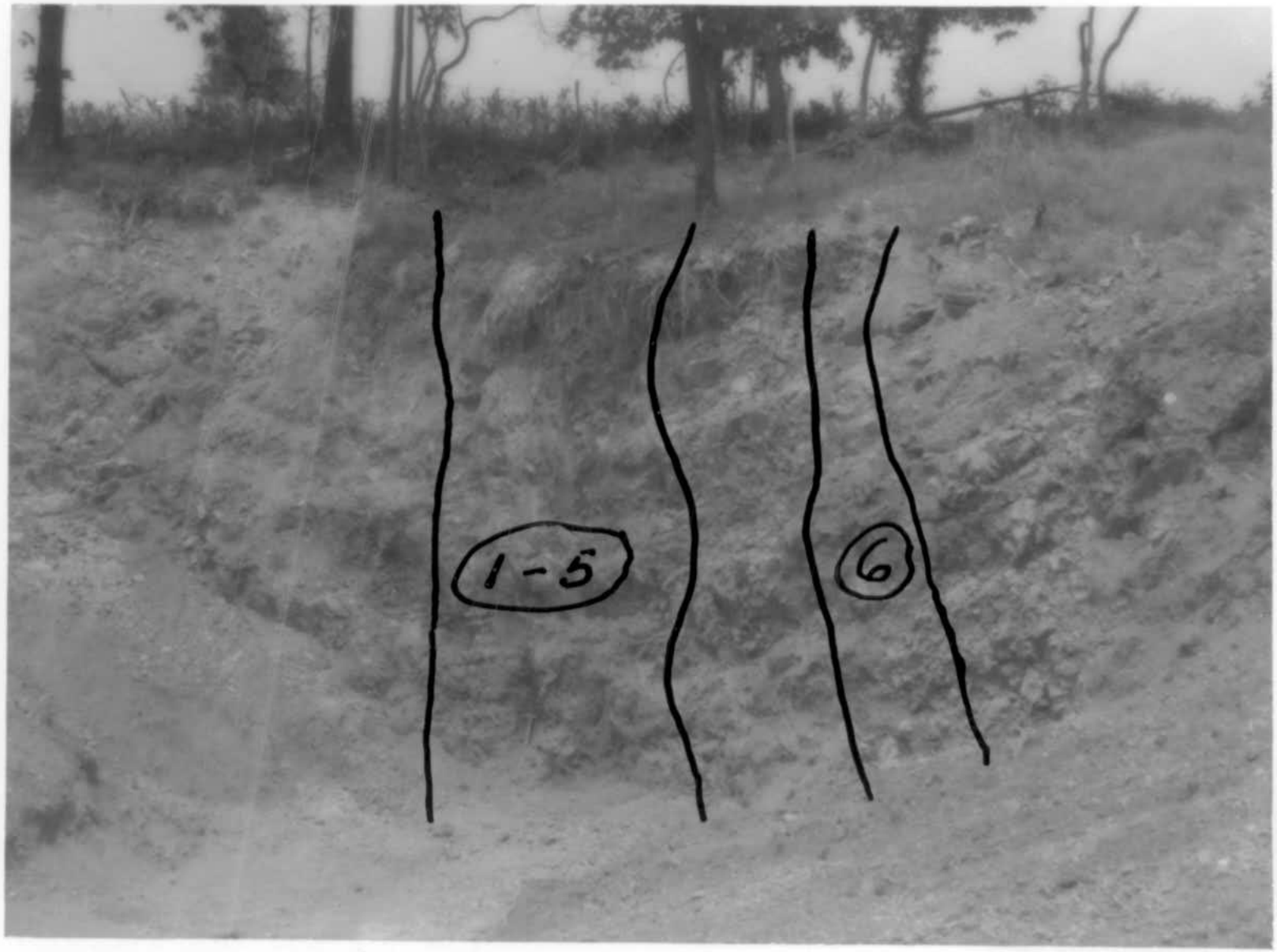


Figure 5 - Closeup of west section of "vein".

Hick's Dome


1-5
6

According to the Illinois Geological Survey: "The yellow clay is different in appearance and physical properties from the red clay. It dries to a rather powdery mass which feels silty; the red clay typically dries to a hard substance resembling brick. Size analyses of the red and yellow clays show that . . . the yellow clay carries twice as much silt as the . . . red clays."

Two possible origins of the radioactive "vein" have been suggested: (1) According to the Illinois Survey: "The yellow clay occurring in 'veins' probably came from an overlying layer of yellow residual clay which has been completely eroded. As cracks opened in the underlying red clay, possibly from slumping into sink holes in the limestone, the yellow clay was washed into the fissures. If these fissures were also watercourses, radioactive substances in the groundwater may have become concentrated in the yellow clay 'veins' by absorption on the clay minerals." (2) The other, and to the writer the more likely possibility is that the structure is the highly weathered remnant of a vein, or possibly a pipe. The doming of formations that has taken place, the mineralized breccia found in the Hemp Oil test hole, the concentration of thorium and rare earths in the veinlike structure, and the presence of rare earths in the Robinson dike, suggest that the mineralization may be more than a groundwater concentration of radioactivity in clay-filled sink holes or fissures.

The object of the proposed work is to uncover and sample the horizontal extension of the "vein" and, if warranted, to obtain by core drilling a sample of the bedrock and "vein" below the weathered zone.

The proposed work is not geologically justified on the basis of exploration for uranium, although the possibility of the presence of uranium cannot be dismissed until more data are obtained.

The combined thorium and rare earth content of the "vein", however, is as much as [illegible] percent in the Reynolds cut. The known data support the theory that a mineralized "vein" occurs in the Reynolds cut and, considering the geologic disturbances that have affected the area, it is a reasonable geologic inference that the mineralized material may continue and perhaps increase in grade below the scattered zone.

Past Production:

There has never been any mining operation on the zone outside of a few hand-dug pits for fluorspar.

Availability of Manpower, etc.:

Manpower is readily available for any type of mining operation in this district. Materials, supplies, and machinery are available at Louisville and Elizabethtown, [illegible], about 10 miles distant, [illegible], Kentucky, 30 miles distant; Herrington, Illinois, 20 miles distant; Paducah, Kentucky, 50 miles distant. Power is available from Rural Electrification Administration lines close at hand. Water is not readily available.

Applicant's Proposed Program:

The amended program is for two bulldozer trenches, 40 feet of core drilling, and necessary sampling, analyses and mapping. The first trench will be at "anomaly 100" at Reynolds cut and will be 250' x 30' x 30'. The second trench will be an extension and deepening of the trench at the Hemp oil hole sludge pond and will be 60' x 30' x 30'. The cost of this work is 20¢/cu.yd. which appears reasonable and adequate to do a workmanlike job.

The 400 feet of core drilling would be approved by the Field Team only if a fairly continuous and mineralized "vein" is exposed in the trenching. A small amount of drill footage is proposed at this time in order to test the feasibility of a larger scale core drilling program and also to test the "vein" in one or possibly two places beneath the weathered zone. For example, if the results of trenching appear encouraging, it would be difficult to decide whether the next exploration stage should be shafting or drilling. The ground is believed to be broken and the depth of weathering is unknown. One or possibly two drill holes would allow the operator and Field Team to intelligently plan, if warranted, further exploration. The exact location of the hole(s) would be determined after the trenching is completed.

Two hundred analyses have been requested at a price of $7.00 each. This appears more than adequate. A topographic map of the work area is worth while. The funds requested seem adequate. The target appears sufficient to justify this work.

W. L. Newmann, Mine Team, Expl. Engineer

October 24, 1955

W. W. Trace, Geologist

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APPLICATION FOR AID IN MINERAL EXPLORATION
PURSUANT TO DMEA ORDER #1
FOR
HICK'S DOME, HARDIN COUNTY, ILLINOIS

W G Reynolds

APPLICANT: W. G. Reynolds
Anchorage, Kentucky

DATE: September 27, 1955

Reviewed by
DMEA OPERATING COMMITTEE

_____
(date)

INTERIM REQUEST FOR MINERAL EXPLORATION PROJECT

HICK'S DOME DOCKET DMEA # 3855

RECEIVED
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Introduction:

The above docketed application for Federal Aid in an exploration project was submitted, June 14, 1955, for exploration assistance under the Defense Production Act of 1950.

A field survey team met with the writer on July 30th at Hick's Dome. These men were Messrs. R. D. Trace, U. S. Geological Survey, G. L. Neumann, Bureau of Mines and V. J. Lynch, Bureau of Mines.

As a result of this field survey and subsequent conferences, we are submitting an Interim Proposal, covering an initial exploration phase, as detailed below.

Depending upon the results obtained from this interim exploration work, we will then submit a revised proposed exploration project, which will encompass the same scope of exploration, as outlined in the originally submitted proposal.

Description of work in Interim Request

It is proposed that two large bulldozed cuts be made across the heart of Hick's Dome. One cut will consist of a trench 250 feet long, starting from the 9 foot wide radioactive rein on the side of the hill from which samples were taken and proceeding in a north westerly direction across the top of the Dome for a distance of 250 feet. This cut will be 30 feet in depth. The width on the top of the cut will be 48 feet tapered to a width of 15 feet at the bottom of the cut. This will require an estimated movement of 8900 cubic yards of earth.

The second cut will consist of the same type of cut as the first, except that it will be 80 feet in length. The depth will also be 30 feet with a 48 foot width at the top tapered to a 15 foot width at the bottom of the cut. The second cut will require removal of approximately 2800 cubic yards of earth and will be made directly across the abandoned Hamp oil well mud pit, which runs north - south. The cut will begin at the edge of the hill and run in a north westerly direction for a distance of 80 feet.

It is felt that these two cuts will expose the heart of the Dome to determine the direction and depth of the radioactive veins that are already present at these two locations.

The first cut described above will particularly determine the extent and direction of the 9 foot wide radioactive vein so that the most promising points for subsequent core drills can be ascertained.

These two cuts when completed will be radiometrically surveyed and samples taken for wet chemical assays for Uranium, Columbium and rare earths.

It is also proposed that one test core hole to a depth of 400 feet be drilled, in order to ascertain the type of sub-surface structure and degree of core recovery for use in subsequent core drilling.

It is further proposed that a topographic map of excavated areas and other portions of the lease be made.

Firm proposals have been received for the bulldozing work and core drilling. The bulldozing proposals are contingent upon no blasting being required and based on previous experience in bulldozing in this particular location, no rock blasting requirement is anticipated by those submitting the bulldozing proposals.

COST SUMMARY

Removal of approximately 11,700 cubic yards at $0.20/cu.yd.	$ 2,340.00
Diamond core drilling one test hole, approximately 400 feet Maximum at $4.00/ft.	1,600.00
Chemical analyses of samples for Uranium, Columbium, etc. (Prices range from $5.00 for U_3O_8 to $18.00 for Columbium and Tantalum)	
200 samples at an average cost of $7.00/sample	1,400.00
Cost of topographic map of excavated areas and other portions of lease	250.00
	$ 5,590.00
10% Contingencies	560.00
TOTAL	$ 6,150.00

SUMMARY

No costs have been included in this interim request for funds to cover overhead, management services or geologists. This interim work will be directed by the writer, who will be on hand to direct the bulldozing, in order to properly follow the 9 foot radioactive vein direction-wise by means of close scintillator check as the work progresses. It is desired to ascertain if this 9 foot vein continues to widen out with depth and further ascertain if it becomes more radioactive with depth. It is also desired to ascertain the approximate length of this particularly radioactive vein. The same applies to the radioactive vein in the mud sump pit covered by the second proposed cut.

The test drill hole is desired to ascertain the feasibility of core recovery at various depths for subsequent diamond core drilling, provided the bulldozed cuts turn up promising results.

It is felt that the highly radioactive veins discovered practically on the surface justify this interim work, prior to proceeding with major exploration work.

B. L. Baxter

B. L. Baxter

September 27, 1955

Sample Designation 1/	Type of material	eU USBM Coll. Pk.	eU USBM Tuscaloosa	eU USGS Wash. Denver	U_3O_8 Van. Corp. of America	U USGS Wash.	CaF_2 USGS Denver	Calculated thorium 2/ USBM Coll. Pk.	—	—
Reynolds 1	Yellow clay, some chert	.032	.036	.035	.05	.004	—	.15	—	—
" 2	Mostly chert, some yell. clay	<.005	.004	.003	.03	.001	—	<.02	—	—
" 3	Yellow clay	.091	.11	.094	.13	.008	—	.45	—	—
" 4	Mostly chert, some yell. clay	.020	.025	.022	.06	.003	—	.10	—	—
" 5	Mostly yellow clay, some chert	.033	.039	.036	.02	.004	—	.15	—	—
" 6	Yellow clay, some red clay	.044	.050	.042	.07	.004	—	.20	—	—
" 7	Lamprophyre, Marion, Ky.	—	—	.002	—	—	—	—	—	—
" 8	Lamprophyre near Hicks Dome	—	—	.003	—	—	—	—	—	—
" 9	Red clay	—	—	.006	—	.004	—	—	—	—
" 10	Intrusive (?) breccia	—	—	.006	—	.003	—	—	—	—

SPECTROGRAPHIC ANALYSES

USGS; Reynolds samples-Washington, Hamp samples-Denver

Sample Designation	>10	5-10	1-5	.5-1	.1-.5	.05-.1	.01-.05	.005-.01	.001-.005	.0005-.001	.0001-.0005
Reynolds 1	Si	—	Al, Fe	K	Ti, Mg, Y, Th, P, Ba, La, Ca, Ce	Nd, Pb, Mn, Sr	Zr, Zn, Na, Be, Cu, Dy, Yb, V, Er, Ni, Gd	Cr, Ga, Lu Sc	Be, Mo	Ag	
" 2	Si	—	Fe	Al	Mn, Ti, K, P	Y, Mg, Ba, Ce, Ca, La	Nd, Pb, Sr, Na, B, Pr, Nb, Sn	Cu, Zr, Co, V, Ni	Yr, Cr, Sc, Cu	Mo	Ag, Be
" 3	Si	Fe	Al	(Ce) K, P (La)	Y, Ba, Ti, Nd, Th, Mg, Ca	Sr, Pb, Pr, Mn	B, V, Er, Nb Tb, Na, Zn	Cu, Gd, Yb Sm, Dy, Ni	Eu, Sn, Ga, Ca Lu, Cr, Sc	Be, Mo	Ag
" 4	Si	—	Al, Fe	P	Ba, Ca, Ti, Y, Ce, Mg K, Th	La, Mn, Pb, Nd	Sr, B, Er, Nb, Na, Pr	Gd, Yb, Dy Cu, V, Ni	Zr, Ga, Co, Eu Sc, Cr, Lu	Be, Mo	Ag
" 5	Si	Al	Fe	—	Y, P, Ti, Mg K, Th, Ba, Ce, Ca, La	Nd, Pb, Sr	Nb, Er, Pr B, Mn, Na, V	Cu, Dy, Yb, Tb, Gd, Zr	Ni, Sc, Cr Eu, Ga, Lu	Be, Mo	Ag
" 6	Si	Al	Fe	(Ti)	Y, Ba, Ca, P K, Mg, Th	Pb, Ce, La	Nd, Na, Yb, Cr, B, Er, V, Pr, Sr, Mn	Cu, Dy, Yb, Gd, Ni, Zn	Sc, Cr, Eu Ga, Lu	Be, Mo, Ag	—
" 7	Si	Fe, Al	Mg, Ca	(Ti) K	Ni, Cr	—	Mn, Ba, Na, Sr, Y, Cu	Co, Ga	La, Yb Y, Pb Nd, Zr, Mo, Sc	—	Yb, Ag, Be
" 8	Si	Fe, Al	(Ti) Mg	Ca, K, Na	Ni, Y, Ba, Ce	Mn, Nd	La, Sr, Y, Co Cr, Zr, Cu	Nb, Zn, Ga	Yb, Pb, Mo, Sc, Be	—	Ag
" 9	Si	Al	Fe	—	Ca, K, Mg, Ti	Ba	Y, Pb, Ni, Sr V, B, Na	Zn, Dy La	Cu, Cr, Yb Ga, Sc, Sn Co, Mo, Mn	—	Be
" 10	Si	Fe	Al	—	K, Ba, Mg, Ti, Ca	Sr, Pb, Mn	Y, V, B, Cu, Na	Zr, Ni, Cy	Cr, La, Ga, Mo, Sc, Yb, Sn	—	Be, Ag
	XX.	X.+	X.	X.−	.X+	.X	.X−	.OX+	.OX	.OX−	.OOX+
Hamp 1	Ca	Si	Mg	Al, Fe	K, Ba	Ti	Na, Th, Y	Mn, Be, Sr	Pb, Zn	Dy, La, Nb Sc, V, Zr	Yb
" 2	Ca	Si	Mg	Al, Fe	K	Ti	Na, Th, Y	Mn, Be, Sr	Ba, Pb, Zn	Dy, La, Nb, Sc V, Zr	Yb
" 3	Ca	Mg	Si	—	Al, Fe, Ba	K	Na	Mn	Ti, Be	Sr	Be, Pb, V, Y
" 4	Ca	Si, Mg	—	—	Al, Fe	Ti	Ba, Y	Mn, Na, Th	Be, Sr	Dy, Nb, V Zr	Yb
" 5	Ca	Si	Fe, Mg	Al, K	—	Ti	Mn, Na	Ba, Ce, Sr, Th, Y	La	Dy, Nd, V	Be, Nb, Sc, Zr
" 6	Ca	Si, Mg	Al, Fe, K	—	Ti	Mn, P, Na	—	Ba, Ce, Sr	La	Nd, Sc, V, Y	Be, Cr, Nb, Zr
" 7	Ca	Si, Mg	—	Fe	Al, K	Ti	Na, Ba	—	Sr	La, Pb	V, Y
" 8	Ca, Si	Mg	—	—	Fe, K	Al, Ba	—	Mn, Na	Ti	Pb, Sr	Be, Y

USBM; College Park, Md.

Sample Designation	>10	>5	1-10	.5-5	.1-1	.08-.8	.05-.5	.03-.3	.02-.2	.01-.1	.008-.08	.005-.05	.003-.03	<.01	<.005	Type of sample
Reynolds 1	Si	Al	Fe	—	—	—	Ti, Mg, Ce	La	Pb, Y	Nd, Sm	V, Zn, Mn, Pr, Yb	Nb, Sc	—	Zr, Cu	Mo	"Vein" 19" wide
" 2	Si	—	—	Al, Fe	—	—	—	Ce	—	Ti, La, Sm	Mg, Mn, Nd, Pr	Y, Sc, Yb	—	V, Nb, Zr, Cu	Mo	"Vein" 17" wide
" 3	Si	Al, Fe	—	—	Ce	Ti, Mg, Nd, La	P, Th, Pr, Y	—	—	V, Sm	Nb, Zn, Pb Mn, Sc, Yb	—	—	Zr, Cu, Mo	—	"Vein" 16" wide
" 4	Si	Al	Fe	—	—	—	Ti, Mg, Ce	La	Y	Nd, Sm	Mn, Pr, Yb	V, Sc	Nb, Zn	Zr, Cu, Pb	Mo	"Vein" 19" wide
" 5	Si	Al	Fe	—	—	—	Ti, Mg, Ce	La	—	Nd, Y, Sm	V, Pr, Yb	Nb, Sc	Zn, Mn	Zr, Cu, Pb	Mo	"Vein" 31" wide
" 6	Si	Al	Fe	—	—	—	Ti, Mg	Ce, Y	—	La, Sm	V, Pb, Nd, Pr, Yb	Nb, Sc	Zn, Mn	Zr, Cu	Mo	"Vein" 16" wide
" 7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Grab
" 8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Grab
" 9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Grab
" 10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Grab
	.OOX	.OOX−	.OOOX+	Trace												
Hamp 1	Cr, Cu	Bi, Ni	—	Ga												Hamp hole 1725'-1750'
" 2	Cr, Cu	Bi, Ni	—	Ga												Hamp hole 1785'-1815'
" 3	—	Nb, Sc, Zr	Cr, Cu, Ni, Yb	—												Hamp hole 1975'-2000'
" 4	Pb, Sc	Cr, Cu	Ni	Bi, La												Hamp hole 2150'-2175'
" 5	Cr, Cu, Yb	Co, Ni	—	Pb												Hamp hole 2370'-2400'
" 6	Ni, Pb, Yb	Co, Cu	—	Dy, Ga, Th												Hamp hole 2425'-2450'
" 7	Be, Cr, Cu, Nb, Sc, Zr	Ni, Yb	Co	Ce, Dy, Ga Th												Hamp hole 2450'-2475'
" 8	Cu, V, Zr	Cr, Nb, Ni, Sc	Yb	—												Hamp hole 2900'-2925'

Note: All analysis figures are percent.
< less than
> greater than

1/ Samples designated Reynolds 1-6 were collected jointly by representatives of the applicant, the Bureau of Mines, and the Geological Survey. The samples were prepared and divided into four splits by the Bureau of Mines, College Park, Md. The applicant's split was analyzed by the Vanadium Corporation of America, Durango, Colorado.
Samples designated Reynolds 7-10, collected by R. D. Trace, and Hamp 1-8, collected by Brown et al., were analyzed by the USGS only. Hamp samples analyzed in 1953, Reynolds samples in 1955.
The location of the samples are as follows:
Reynolds 1-6 and 9 are from the Reynolds cut (Fig. 2).
Reynolds 7 is from a lamprophyre dike about 2 miles southwest of Marion, Ky.
Reynolds 8 is from the Robinson lamprophyre dike (fig. 2).
Reynolds 10 is from a large boulder of intrusive(?) breccia on the Reynolds property (fig. 2).
Hamp 1-8 are the same samples described by Brown et al. in Econ. Geol. They are cuttings from the Hamp oil test hole. The depths of the samples are given in the right hand column of the above table.

2/ Calculated thorium is based on radiometric and X-ray spectrographic analysis, and is ±10 percent.

TABLE 1.--ANALYSES OF SAMPLES FROM HICKS DOME, HARDIN COUNTY, ILLINOIS -- DMEA 3855

R.D.T. 10-16-55

Sample Designation 1/	Type of material	eU USBM Coll. Pk.	eU USBM Tuscaloosa	eU USGS Wash. Denver	U_3O_8 Van. Corp. of America	U USGS Wash.	CaF_2 USGS Denver	Calculated thorium 2/ USBM Coll. Pk.	Th USGS Wash.
Reynolds 1	Yellow clay, some chert	.032	.036	.035	.05	.004	—	.15	0.3
" 2	Mostly chert, some yell. clay	<.005	.004	.003	.03	.001	—	<.02	0.1
" 3	Yellow clay	.091	.11	.094	.13	.008	—	.45	0.6
" 4	Mostly chert, some yell. clay	.020	.025	.022	.06	.003	—	.10	0.2
" 5	Mostly yellow clay, some chert	.033	.039	.036	.02	.004	—	.15	0.2
" 6	Yellow clay, some red clay	.044	.050	.042	.07	.004	—	.20	0.3
" 7	Lamprophyre, Marion, Ky.	—	—	.002	—	—	—	—	—
" 8	Lamprophyre near Hicks Dome	—	—	.003	—	—	—	—	—
" 9	Red clay	—	—	.006	—	.004	—	—	—
" 10	Intrusive (?) breccia	—	—	.006	—	.003	—	—	—

SPECTROGRAPHIC ANALYSES

USGS; Reynolds samples-Washington, Hamp samples-Denver

Sample Designation	>10	5-10	1-5	.5-1	.1-.5	.05-.1	.01-.05	.005-.01	.001-.005	.0005-.001	.0001-.0005
Reynolds 1	Si	—	Al, Fe	K	Ti, Mg, Y, Th, P, Ba, La, Ca, Ce	Nd, Pb, Mn, Sr	Zr, Zn, Na, Be, Nb, Pr, Tb	Cu, Dy, Yb, V, Er, Ni, Gd	Cr, Ga, Lu, Sc	Be, Mo	Ag
" 2	Si	—	Fe	Al	Mn, Ti, K, P	Y, Mg, Ba, Ce, Cu, La	Nd, Pb, Sr, Na, B, Pr, Nb, Sn	Cu, Zr, Co, V, Ni	Yr, Cr, Sc, Lu	Mo	Ag, Be
" 3	Si	Fe	Al	Co, K, P, La	Y, Ba, Ti, Nd, Th, Mg, Ca	Sr, Pb, Pr, Mn	B, V, Er, Nb, Tb, Na, Zn	Cu, Gd, Yb, Sm, Dy, Ni	Eu, Sn, Ga, Co, Lu, Cr, Sc	Be, Mo	Ag
" 4	Si	—	Al, Fe	P	Ba, Cu, Ti, Y, Ce, Mg, K, Th	La, Mn, Pb, Nd,	Sr, B, Er, Nb, Na, Pr	Gd, Yb, Dy, Cu, V, Ni	Dy, Ga, Co, Eu, Sc, Cr, Lu	Be, Mo	Ag
" 5	Si	Al	Fe	—	Y, P, Ti, Mg, K, Th, Ba, Ce, Ca, La	Nd, Pb, Sr	Yb, Er, Pr, B, Mn, Na, V	Cu, Dy, Yb, Tb, Gd, Zr	Ni, Sc, Cr, Eu, Ga, Lu	Be, Mo	Ag
" 6	Si	Al	Fe	Ti	Y, Ba, Cu, P, K, Mg, Th	Pb, Ce, La	Nd, Na, Yb, Cr, B, Er, V, Pr, Sr, Mn	Cu, Dy, Yb, Gd, Ni, Zn	Sc, Cr, Eu, Ga, Lu	Be, Mo, Ag	—
" 7	Si	Fe, Al	Mg, Ca	Ti, K	Ni, Cr	—	Mn, Ba, Na, Sr, V, Cu	Co, Ga	La, Yb, Y, Pb, Nd, Zr, Mo, Sc	—	Yb, Ag, Be
" 8	Si	Fe, Al	Ti, Mg	Ca, K, Na	Ni, Y, Ba, Ce	Mn, Nd	Lu, Sr, Y, Co, Cr, Zr, Cu	Nb, Zn, Ga	Yb, Pb, Mo, Sc, Be	—	Ag
" 9	Si	Al	Fe	—	Ca, K, Mg, Ti	Ba	Y, Pb, Ni, Sr, V, B, Na	Zn, Dy, La	Cu, Cr, Yb, Ga, Sc, Sn, Co, Mo, Mn	—	Be
" 10	Si	Fe	Al	—	K, Ba, Cu, Mg, Ti, Ca	Sr, Pb, Mn	Y, V, B, Cu, Na	Zr, Ni, Dy	Cr, La, Ga, Mo, Sc, Yb, Sn	—	Be, Ag
	xx.	x.+	x.	x.−	.x+	.x	.x−	.ox+	.ox	.ox−	.oox+
Hamp 1	Ca	Si	Mg	Al, Fe	K, Ba	Ti	Na, Th, Y	Mn, Be, Sr	Pb, Zn	Dy, La, Nb, Sc, V, Zr	Yb
" 2	Ca	Si	Mg	Al, Fe	K	Ti	Na, Th, Y	Mn, Be, Sr	Ba, Pb, Zn	Dy, La, Nb, Sc, V, Zr	Yb
" 3	Ca	Mg	Si	—	Al, Fe, Ba	K	Na	Mn	Ti, Be	Sr	Be, Pb, V, Y
" 4	Ca	Si, Mg	—	—	Al, Fe	Ti	Ba, Y	Mn, Na, Th	Be, Sr	Dy, Nb, V, Zr	Yb
" 5	Ca	Si	Fe, Mg	Al, K	—	Ti	Mn, Na	Ba, Ce, Sr, Th, Y	La	Dy, Nd, V	Be, Nb, Sc, Zr
" 6	Ca	Si, Mg	Al, Fe, K	—	Ti	Mn, P, Na	—	Ba, Ce, Sr	La	Nd, Sc, V, Y	Be, Cr, Nb, Zr
" 7	Ca	Si, Mg	—	Fe	Al, K	Ti	Na, Ba	—	Sr	La, Pb	V, Y
" 8	Ca, Si	Mg	—	—	Fe, K	Al, Ba	—	Mn, Na	Ti	Pb, Sr	Be, Y

USBM; College Park, Md.

Sample Designation	>10	>5	1-10	.5-5	.1-1	.08-.8	.05-.5	.03-.3	.02-.2	.01-.1	.008-.08	.005-.05	.003-.03	<.01	<.005
Reynolds 1	Si	Al	Fe	—	—	—	Ti, Mg, Ce	La	Pb, Y	Nd, Sm	V, Zn, Mn, Pr, Yb	Nb, Sc	—	Zr, Cu	Mo
" 2	Si	—	—	Al, Fe	—	—	—	Ce	—	Ti, La, Sm	Mg, Mn, Nd, H	Y, Sc, Yb	—	V, Nb, Zr, Cu	Mo
" 3	Si	Al, Fe	—	—	Ce	Ti, Mg, Nd, La	P, Th, Pr, Y	—	—	V, Sm	Nb, Zn, Pb, Mn, Sc, Yb	—	—	Zr, Cu, Mo	—
" 4	Si	Al	Fe	—	—	—	Ti, Mg, Ce	La	Y	Nd, Sm	Mn, Pr, Yb	V, Sc	Nb, Zn	Zr, Cu, Pb	Mo
" 5	Si	Al	Fe	—	—	—	Ti, Mg, Ce	La	—	Nd, Y, Sm	V, Pr, Yb	Nb, Sc	Zn, Mn	Zr, Cu, Pb	Mo
" 6	Si	Al	Fe	—	—	—	Ti, Mg	Ce, Y	—	La, Sm	V, Pb, Nd, Pr, Yb	Nb, Sc	Zn, Mn	Zr, Cu	Mo
" 7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
" 8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
" 9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
" 10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	.oox	.oox−	.oox+	Trace	Type of sample										
Hamp 1	Cr, Cu	Bi, Ni	—	Ga	Hamp hole 1725'-1750'										
" 2	Cr, Cu	Bi, Ni	—	Ga	Hamp hole 1785'-1815'										
" 3	—	Nb, Sc, Zr	Cr, Cu, Ni, Yb	—	Hamp hole 1975'-2000'										
" 4	Pb, Sc	Cr, Cu	Ni	Bi, La	Hamp hole 2150'-2175'										
" 5	Cr, Cu, Yb	Co, Ni	—	Pb	Hamp hole 2370'-2400'										
" 6	Ni, Pb, Yb	Co, Cu	—	Dy, Ga, Th	Hamp hole 2425'-2450'										
" 7	Be, Cr, Cu, Nb, Sc, Zr	Ni, Yb	Co	Ce, Dy, Ga, Th	Hamp hole 2450'-2475'										
" 8	Cu, V, Zr	Cr, Nb, Ni, Sc	Yb	—	Hamp hole 2900'-2925'										

Note: All analysis figures are percent.
< less than
> greater than

1/ Samples designated Reynolds 1-6 were collected jointly by representatives of the applicant, the Bureau of Mines, and the Geological Survey. The samples were prepared and divided into four splits by the Bureau of Mines, College Park, Md. The applicant's split was analyzed by the Vanadium Corporation of America, Durango, Colorado.
Samples designated Reynolds 7-10, collected by R. D. Trace, and Hamp 1-8, collected by Brown et al., were analyzed by the USGS only. Hamp samples analyzed in 1953, Reynolds samples in 1955.
The location of the samples are as follows:
Reynolds 1-6 and 9 are from the Reynolds cut (Fig.10). (Anomaly 100)
Reynolds 7 is from a lamprophyre dike about 2 miles southwest of Marion, Ky.
Reynolds 8 is from the Robinson lamprophyre dike (fig.10).
Reynolds 10 is from a large boulder of intrusive(?) breccia on the Reynolds property (fig.10).
Hamp 1-8 are the same samples described by Brown et al. in Econ. Geol. They are cuttings from the Hamp oil test hole. The depths of the samples are given in the right hand column of the above table.

2/ Calculated thorium is based on radiometric and X-ray spectrographic analysis, and is ±10 percent.

FIGURE 11.--ANALYSES OF SAMPLES FROM HICKS DOME, HARDIN COUNTY, ILLINOIS -- DMEA 3855

R.D.T. 1-1-57 10-16-55