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URBANA

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# PRELIMINARY REPORT ON URANIUM IN HARDIN COUNTY, ILLINOIS

BY

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## ABSTRACT

Hicks dome in Hardin 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 1 1/2 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, zinc and lead ores, and concentrates from these ores have little or no radioactivity as measured by a laboratory Geiger counter. $U_3O_8$ determinations made by chemical procedures 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.

## INTRODUCTION

Within the last six months considerable public interest has been aroused by the reported presence of radioactive materials on Hicks dome in Hardin County, Ill. Continuing interest has been maintained by reports* that have mentioned samples ranging from 0.10% to 0.21% $U_3O_8$, and leasing, test pitting and trenching, and sampling has been under way in the area.

As in the case of any new potential mineral resource in the State, the Illinois Geological Survey has made reconnaissance field studies to investigate basic facts about the deposits for the benefit of owners and prospectors and for the information of all citizens of the State. A large number of samples have been tested radiometrically and some of those that showed higher radioactivity have been chemically analyzed for uranium.

*Hardin County Independent, March 17, 1955, p. 1.

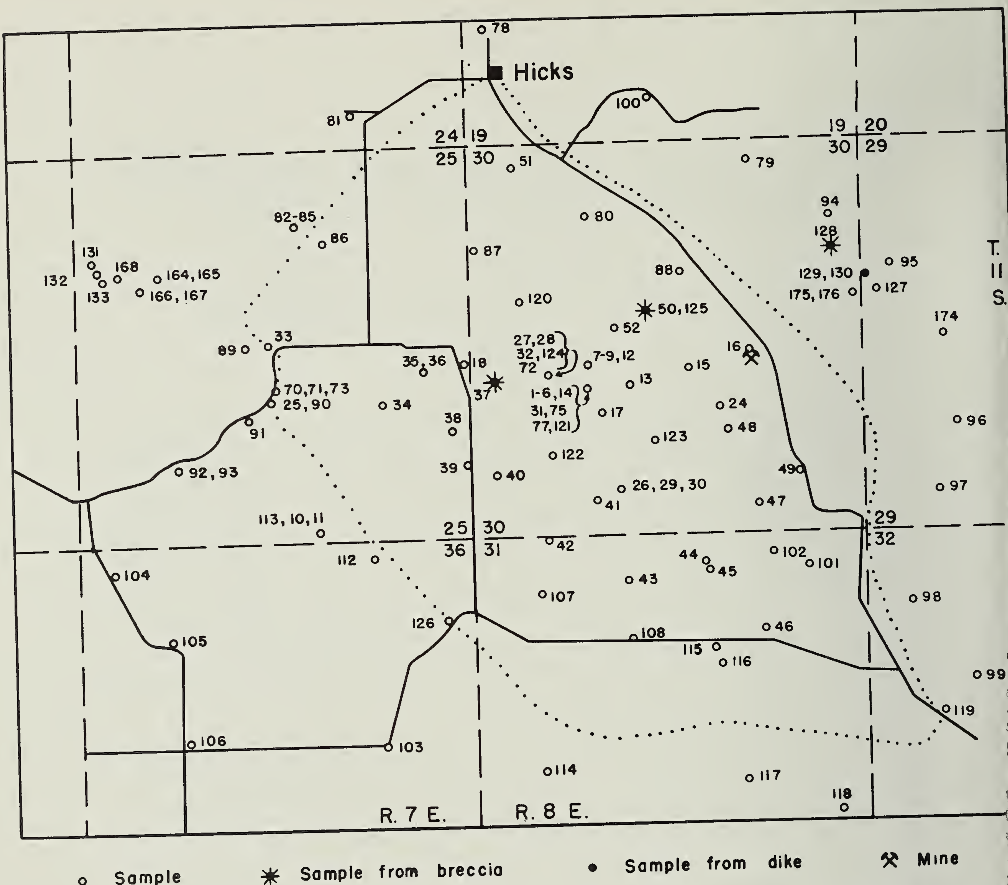


Fig. 1 - Sketch map showing sample locations on Hicks Dome and vicinity. Roads are shown by solid lines. The approximate limits of the area underlain by rocks of Devonian-New Albany age are indicated by a dotted line.

Because of the widespread public interest in Hicks dome, this progress report has been prepared to make available the Geological Survey's information as of this date. As our investigations are incomplete, all deductions and hypotheses expressed herein are subject to revision as investigations proceed further and additional data become available. The basic analytical data presented here, however, are of more lasting value.

## GEOLOGY OF HICKS DOME

Hicks dome, which is both a structural and a topographic feature, is located about 7 1/2 miles north of Rosiclare, centering in sec. 30, T. 11 S., R. 8 E. Although the beds dip outward for several miles from the center of the dome, for the purposes of this report the term "Hicks dome area" will be given the approximate geographic limitations shown on the map (fig. 1). The central part of the dome, referred to in this report as "Hicks dome," is an area of about 1 1/2 square miles; most of the prospecting for uranium has been concentrated there. It is underlain by Devonian limestone and chert identified from drilling as the Clear Creek formation (Brown et al., 1954). The surface is now covered by red cherty clay, a residue from the weathering of the cherty limestone.

A circular belt about 1/4 to 3/8 mile wide around the central part of the dome is underlain by black carbonaceous New Albany shale, which shows some radioactivity. Information on the rocks at depth is contained in the log of the Fricker well on the southeastern side of the dome (Weller et al., 1952) and in the report by Brown et al. (1954) on the Hamp well, an oil-test on the central part of the dome.

Exposures of two mica-peridotite dikes and three occurrences of explosion breccia are evidences of igneous activity in the Hicks dome area. In addition, a well (the Hamp well) was drilled through explosion breccia from 1725 feet to the bottom of the well at 2925 feet. All exposures except a dike on the Joiner farm are shown on figure 1. The Joiner farm dike is shown on the geologic map in Illinois Geological Survey Bulletin 76 (Weller et al., 1952) as occurring in the SE 1/4 sec. 25, T.11 S., R. 7 E., but it apparently no longer crops out.

Faults are difficult to recognize because of the nature of the materials exposed on Hicks dome, but it is believed that such faults as may be present are small and of limited extent. A chert breccia in slickensided wall-like bodies was found at scattered places. One such outcrop protrudes several feet above the ground for a distance of about 75 feet. Most of the slickensided walls had a general northeast strike, ranging from N. 20 E. to N. 60 E. This is the prevailing trend of the faults in Hardin County.

The exact origin of Hicks dome is not completely known. Its upward arching may have been associated with the structural movements that produced the faulting that is common in Hardin County and adjacent parts of Kentucky and is locally complex. An alternate hypothesis is that the dome reflects the localized intrusion of a mass of igneous material at considerable depth, from which the peridotite dikes and explosion breccia are offshoots. A third hypothesis (Brown et al., 1954) also involves a molten mass at depth but suggests that the doming was caused by gases evolved from the igneous rock or by steam from groundwater heated by the intrusion. Thus the explosive release of the gases may have caused the breccias found on the dome. However, occurrences of explosion breccia in areas away from the dome, for example, near Sparks Hill and one mile west of Rosiclare, throw doubt on the significance of such breccia in the formation of Hicks dome.

## METHOD OF SAMPLE ANALYSIS

The sampled materials, described below, were crushed in a jaw crusher to approximately 1/8 inch. Radiometric analyses of the samples were made with a laboratory model Geiger counter which had been calibrated against samples of known $U_3O_8$ content obtained from the Atomic Energy Commission.

Determinations of $U_3O_8$ were made according to the Atomic Energy Commission's booklet, "Manual of Analytical Methods for the Determination of Uranium and Thorium in Their Ores." A Beckman Model DU spectrophotometer with 10 cm. Corex cells was used for the color measurement.

A standard curve of transmittance was prepared by analysis of various dilutions of a sample of phosphate rock of known $U_3O_8$ content obtained from the Atomic Energy Commission. Results of the Illinois Survey analyses of standard samples compared satisfactorily with the Atomic Energy Commission's values for the same samples.

## OCCURRENCE AND NATURE OF MATERIALS SAMPLED FROM HICKS DOME AREA

All types of earth materials present at the surface in the Hicks dome are and in test pits and trenches up to 20 feet deep were tested in the field with a portable Geiger counter and sampled for analysis in the Survey laboratories. Included in the field examination were red, yellow, and brown clay, chert, sar stone (minor amount), fault (?) breccia, explosion breccia, peridotite dikes, black marine shale (New Albany), massive limonite, and calcite and fluorite. Only the clays, some of the fault (?) breccia, and some of the New Albany sha showed appreciable radioactivity. Some pieces of the explosion breccia show weak radioactivity whereas others showed none. The dikes were very weakly radioactive. The rest of the material showed little to no radioactivity.

### Clays

Most of the cherts and the clays, which are principally red or yellow, ap pear to be residual from the weathering of a limestone that contained chert a nodules and beds as much as several feet thick. The red clay present over r of the dome has the typical color and appearance of residual clay from limes X-ray diffraction patterns of the minus 2 micron or clay-size fraction of two samples (nos. 18 and 38, table 1) established the absence of any characterist cally crystalline clay mineral in sufficient abundance to be identified. Heter geneous weathered assemblages of this nature are often observed in clays re sidual from limestone.* As sample 18 was moderately radioactive and sam

*Bradley, W. F., personal communication.

ple 38 was virtually nonradioactive, there is apparently no relationship between clay mineralogy and radioactivity.

On the central part of the dome, the yellow clay occurs as vertical "veins" and irregular masses in the red clay and commonly carries much higher values in radioactivity than the surrounding red clay. 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 (table 2) show that sample 72, the yellow clay, carries twice as much silt (-325 + 2 microns) as the two red clays and much less clay-size material than sample 18, a red clay. The relative scarcity of clay-size particles in the other red clay, sample 38, is probably due to the fact that a large part of that sample was composed of chert fragments. Otherwise sample 38 is similar to sample 18 - in color, texture, and drying characteristics.

An x-ray diffraction pattern of the minus 2 micron fraction of the yellow material showed the same characteristics as the red clays. 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. As these fissures were also watercourses, radioactive substances in the groundwater may have become concentrated in the yellow clay "veins" by adsorption on the clay minerals. The data in table 2 suggest some sort of relationship between the amount of the clay fraction and radioactivity.

On the eastern flank of the dome, in the vicinity of the Robinson dike (sample 130), a bulldozer-cut exposed a yellow residual clay overlying Mississippian Osage chert. The yellow clay on the Robinson property was radioactive only at the contact with the underlying chert bedrock (sample 175), indicating a concentration by groundwater at the surface of the bedrock. Sample 176 was taken from a two-foot wide radioactive zone in broken chert at the southeastern side of the dike as exposed in the trench. The dike itself had been weathered in place to a soft material that was easily cut by the bulldozer. The material of sample 176 showed as strong a reading on the portable Geiger counter in the wall of the trench as did that of sample 175, but when tested five days later by a laboratory counter it was only weakly radioactive (see table 3). As the material had been sampled as soon as it was exposed by the bulldozer, the radioactivity may have been caused by radon gas.

Another type of yellow clayey material is exposed for about 1000 feet along a stream and its tributaries on the northwestern flank of the dome in the NW 1/4 sec. 25 and the NE 1/4 sec. 26 (samples 131 to 133 and 168). It is moderately radioactive in spots and is composed mainly of fragments of weathered chert, although an occasional fragment of sandstone or shale can be found. The material is soft except for the few sandstone fragments, and the chert offers no more resistance to a knife blade than does the interstitial clayey material. Some stratification can be found and is contorted in places. Apparently the material is a strongly weathered chert gravel. No differences in included materials, texture, or structure could be found between the radioactive and nonradioactive portions.

## Chert and Sandstone

The chert exposed in trenches and as an occasional outcrop does not appear to be significantly radioactive (table 1) with the exception of sample 72D. This sample is from a one-foot bed of soft weathered white chert with brown laminations exposed in the wall of a trench. The only sandstone found was a few blocks in a sinkhole exposed in a trench and one small piece on a hillside (sample 88, table 1). None of it was radioactive.

## Fault (?) Breccia

The material called fault (?) breccia is composed of chert or other silicified rock fragments cemented by fine-grained to microcrystalline quartz. Th breccia generally occurs as slickensided wall-like bodies which may protrude above the ground (sample localities 10 (11) and 25) or be completely covered by residual clay (locality of samples 1 through 6 and 77).

The breccia fragments appear to have come from the immediately surrounding rocks, which seem to have been only fractured with none of the grind ing expectable from a large amount of movement along a fault. No stratigrapl evidence of faulting was found because of the scarcity of outcrops. However, we saw no difference in the soil or residuum surrounding the breccia outcrop from one side of the outcrop to the other, so that movement on the faults was not sufficient to have brought different kinds of rock into contact.

An alternative theory of formation of the breccia is one invoking explosiv gases. The fault (?) breccia would merely represent a lesser degree of disturbance than that shown by the explosion breccia. The slickensides, which transect the cement as well as the rock fragments, could have been caused by minor adjustments along the plane of the disturbance after the explosive activity had ceased.

Appreciable radioactivity in the fault (?) breccia was detected only at the locality of samples 1 through 6, a ridge exposed in a test pit. One sample (no 12) from boulders on the opposite side of the same hill also showed moderate radioactivity, but all samples from other localities showed only weak or no ra dioactivity. The great variation in amount of radioactivity between samples from the same locality indicates that the distribution of the radioactive mate rial in the breccia is "spotty." It suggests that the lack of appreciable radio activity shown by samples from the other localities may be due to the chance missing of radioactive segregations during sampling. Such is not believed to be the case because all breccia outcrops were checked with the portable Geig counter and only localities of samples 1 through 6 and 12 had shown a count o more than twice background.

A microscopic examination of the breccia failed to reveal the presence o uranium minerals, but an ever-present iron-oxide stain could hide any powd coatings of normally brightly colored secondary uranium minerals. As the chert itself is not radioactive, the radioactivity must be related to the fine-grained quartz cement. The cementing material is generally vesicular and here and there is present only as a drusy coating around the chert fragment Generally there is not sharp boundary between the cementing quartz and the chert, indicating some replacement of the chert by the quartz. Whether the quartz of the cement was deposited from hydrothermal solutions related to the igneous activity or from circulating groundwater cannot be determined at present, but the great quantity of silica available in the Devonian chert certainly makes a hydrothermal source unnecessary. That groundwater is an adequate carrier of silica is attested by the quartz veinlets and druses associated with many siliceous sediments as well as the well-crystallized quartz found in many geodes.

## Explosion Breccia

The terms explosion breccia and intrusive breccia have been used in Hardin County to designate a rock composed of pieces of sedimentary and igneous rocks in a fine-grained altered matrix which includes fragments of the minerals feldspar, mica, pyroxene, and apatite (Weller et al., 1952). Brown et al. (1954) concluded that the breccia in the Hamp well also was an explosion breccia, although it contained no recognizable igneous material. The breccia at sample localities 37, 50 (125), and 128 was called explosion breccia in the field because of its similarity in appearance to described occurrences of that breccia elsewhere in Hardin County.

Sample locality 50 (125) is a small steep-sided rounded hill several hundred feet in diameter liberally sprinkled with boulders of a material composed of angular fragments of chert in a fine-grained matrix. In places the matrix appears to be composed largely of iron oxide, but generally the cementing material is fine-grained to microcrystalline quartz. The included fragments vary in size from about 6 inches down to the granular material of the matrix.

In mineral composition the breccia of locality 50 (125) is similar to the fault (?) breccia described earlier but differs in degree of brecciation and in area and shape of outcrop. The fault (?) breccia appears to be composed of fragments about 1/2 inch or larger whereas the material of locality 50 (125) contains areas in which the fragments measure no more than a millimeter or so. The differences in area and shape of outcrop of the two occurrences are great and appear to suggest different modes of origin. If the hill of locality 50 (125) is underlain entirely by the breccia, as would appear to be the case from the absence of other kinds of rock either as float blocks or outcrops, the breccia has an outcrop area roughly circular in plan and several hundred feet in diameter. Such an outcrop area would be expected from a pipe-like body. By contrast, the more typical fault (?) breccia occurs in narrow wall-like bodies about 2 to 3 feet wide and up to 75 feet long, suggestive of fault outcrops.

The other two occurrences designated as explosion breccia in figure 1 are intermediate in amount of brecciation between the fault (?) breccia and the breccia pipe. They are both chert breccias cemented by silica and iron oxide. The outcrop of no. 128 is small, and no. 37 is represented only as boulders, so the extent of the bodies is not known. The existence of breccia of the character of nos. 128 and 37, in a sense transitional between the two extremes, suggests that all the breccia of the Hicks dome area might have originated from the same source - explosive release of gases.

The radioactivity of the explosion breccia was found to be low, both in outcrop measurements and in representative samples tested in the laboratory. However, analyses of eight 25-foot samples of cuttings from the breccia portion of the Hamp well (Brown et al., 1954) showed four to be moderately radioactiv with the radiometric values ranging from 0.01% eU to 0.03% eU. The low leve of radioactivity of the exposed breccias may be due to leaching or more probably to the chance that the present erosion surface does not cut a portion of th rock that contains a segregation of radioactive material. The generally low values of the chemical analyses for uranium of the Hamp samples show that the radioactive material is something other than uranium.

### Peridotite Dikes

Two occurrences of mica peridotite are known in the Hicks dome area. A dike on the Joiner farm in the SE 1/4 sec. 25 is mentioned by Grogan in Illino Geological Survey Bulletin 76 (Weller et al., 1952). Samples collected by Grogan were found to be but slightly radioactive (sample 147). On the Robinson farm on the east side of the dome a weathered dike is exposed in a test pit (sample 130) and in the bulldozer trench from which clay samples 175 and 17 were taken. The dike strikes N. 57° E., in contrast to the northwestward stri of all other known dikes in Hardin County. The only recognizable mineral remaining in this thoroughly weathered dike is mica, in books and plates up to 1/2 inch wide. The weathered material was even less radioactive than the Joiner dike.

### New Albany Shale

The New Albany shale, which encircles the central part of Hicks dome in a band 1/2 to 3/8 mile wide, is a black carbonaceous marine shale. Samples 70a through 70e represent successive 5-foot vertical intervals from the outcrop in the creek just off the bend in the road in the NW 1/4 SE 1/4 sec. 25. A shear zone one foot wide, containing traces of fluorite, showed abnormal radioactivity in the field, but in the laboratory a sample from this zone tested no higher than the other shale samples.

### Miscellaneous Materials

Boulders of massive limonite up to one foot in diameter (sample 45) and calcite and fluorite (sample 92) were only weakly radioactive.

## MATERIAL SAMPLED IN OTHER HARDIN COUNTY LOCATIONS

In an attempt to find whether or not there is any definite association of radioactive anomalies with specific types of geologic phenomena, such as faulting or igneous activity, materials were sampled at various localities throughout the fluorspar-producing district of Hardin and Pope counties. The samp included clays and shales from fault zones, residual clays from undisturbed limestone and sandstone, peridotite dikes and explosion breccias and clays overlying them, ores of fluorspar, lead, and zinc, and concentrates from su ores. Results of tests on these samples are shown in table 3.

In general, of the types of clays sampled, only those from fault zones sh ed more than very slight radioactivity. Clay sample 66 from the Rosiclare system, clay sample 55 and shale sample 54 from the Peters Creek fault at its outcrop along Route 146, and black shale sample 61 from a dump beside a fluorspar prospect shaft on the Wolrab Mill fault near Sparks Hill registered nearly twice background on the laboratory Geiger counter. However, clay sample 65 from the Rosiclare vein system and clay sample 64 from the roadside near the junction of the Wolrab Mill and Stewart faults showed very slight radioactivity.

One occurrence of radioactive residual clay is in a road cut in the Hardinsburg sandstone on the Karbers Ridge road. The radioactivity was concentrated in a zone 6 to 12 inches thick in the yellow residual clay at the top of the shale bedrock. Apparently this was a concentration by groundwater. It is possible that the source of the radioactive material in this instance was the black shale beds that occur at intervals in the upper Chester formations. No faults are known in the immediate vicinity and certainly none were visible in the outcrop.

A bulldozer-cut in the hillside south of the road disclosed a yellow clay-filled pocket two feet wide containing three 1/2-inch red clay-filled fissures which were quite radioactive (sample 162). Comparison of this occurrence with the abnormally radioactive yellow clay-filled fissures in red clay found on Hicks dome proves that color of clay has little bearing on amount of radioactivity.

Of the peridotite dikes sampled, two (samples 154 and 148) showed moderate radioactivity and the others showed none. A sample of red clay, no. 110, from a stream cut on the strike of the dike of sample 148 but 150 feet southeast of the outcrop was only very weakly radioactive.

The explosion breccias outside the Hicks dome area and the clays overlying them showed weak to no radioactivity. In addition to the samples shown in table 3, the outcrop localities of the breccias were thoroughly prospected with the Geiger counter, and the surface clays were tested at a great many additional spots by utilizing animal burrows and by digging holes 18 inches in depth.

Lead, zinc, and fluorspar ores and concentrates from the Rosiclare district, the Cave in Rock district, and the outlying Empire district in Pope County were tested but showed virtually no radioactivity.

## SUMMARY OF RESULTS OF ANALYSES

Tables 1 and 3 give the results of uranium equivalent (eU) tests and chemical determinations of uranium oxide. The uranium equivalent data indicate the total radioactivity of the samples expressed in terms of $U_3O_8$ (uranium oxide). Thus they indicate the amount of $U_3O_8$ in a sample plus any other radioactive substances present. The chemical determinations of $U_3O_8$ show only uranium oxide.

In the summary tables 4 and 5, the various types of materials tested are considered in two categories: (1) samples taken from exposures within the areas underlain by Devonian rocks and New Albany shale on Hicks dome (fig. 1), and (2) those outside this area. This distinction is made because the Devonian-New Albany area often is referred to popularly as the "dome" or as being "on the dome."

The most radioactive materials are generally red and yellow clays. It appears that the clays and breccias within the Devonian area are somewhat more radioactive than similar materials elsewhere in the county, though there are some exceptions. Samples of fluorspar, zinc and lead ores, and concentrates from these ores have slight or no radioactivity. The $U_3O_8$ content of all samples tested for both uranium equivalent and $U_3O_8$ was considerably below the uranium equivalent figure and also was below the minimum of 0.1 percent on which prices are quoted by the Atomic Energy Commission.

## SOURCE OF RADIOACTIVE MATERIAL

The source of the radioactive material is an unsolved problem at the present stage of investigation. Two possible sources exist - sedimentary and hydrothermal. The New Albany shale, which encircles and at one time covered the central part of Hicks dome, offers a potentially adequate source for the radioactivity within its outcrop boundary. The black shales of the upper Chester formations are a possible source of the radioactivity of samples 158 throug 162, taken outside the Hicks dome area (see table 3).

Evidence for an association of radioactivity with igneous phenomena is the moderate radioactivity of two peridotite dikes, samples 154 and 148, and of the breccia in the Hamp well. Also the weak radioactivity of the clays from the Peters Creek and Rosiclare fault systems may well be due to hydrothermal solutions. However, the virtual lack of radioactivity in the fluorspar, lead, and zinc ores of the district suggests that the radioactive occurrences are not directly related to fluorspar mineralization.

The present radioactive concentrations give little hint as to the origin of the radioactive materials. As virtually all the prospecting has been surface work, the only radioactive materials exposed are clays and weathered chert breccias. The radioactivity in the clays is almost certainly due to concentration by groundwater, judging from the concentrations in fissures and at the su face of the bedrock. The one occurrence of radioactive fault (?) breccia, regarded by some observers as the weathered outcrop of a hydrothermal vein, could have acquired its radioactivity from groundwater circulating through th vesicular quartz cement or even from groundwater that may have deposited tl quartz.

The best evidence for a hydrothermal origin is in the distribution of the more radioactive samples. Those inside the ring of shale could have acquire their radioactivity from the weathering of the shale, but the three outside (an above) the shale more reasonably would be assumed to have another source. As there is no black carbonaceous shale within 1000 feet stratigraphically ab e the lower Mississippian formations at the three localities, the weathering of - drothermal veins is a likely source of the radioactivity.

Only prospecting at deeper levels will determine whether there is any dc ward extension of suspected veins, or whether the radioactive occurrences a merely concentrations by groundwater from the weathering of weakly radioac tive rocks.

Table 1. - Results of Tests on Samples from Map Area (Fig. 1)

(Analyses by L. D. McVicker, Geochemical Section, Illinois State Geol. Survey)

| Sample No. | Material | Location sec. | T. | R. | Analyses % eU | % $U_3O_8$ | Remarks |
|---|---|---|---|---|---|---|---|
| | Clays | | | | | | |
| 13 | Red | 30 | 11S | 8E | .010 | | 2 feet below surface |
| 14 | Red | 30 | 11S | 8E | .013 | .003 | Test pit, 5 feet deep |
| 15 | Red | 30 | 11S | 8E | .004 | | 1 1/2 feet below surface |
| 16 | Red | 30 | 11S | 8E | .012 | | Waste pile, Rose Mine |
| 17 | Red | 30 | 11S | 8E | .004 | | From hillside |
| 18 | Red | 25 | 11S | 7E | .021 | .009 | Roadside ditch |
| 24 | Red | 30 | 11S | 8E | .004 | | From pit |
| 27A | Red | 30 | 11S | 8E | .144 | .014 | In gully |
| 27B | Red | 30 | 11S | 8E | .080 | .004 | In gully |
| 28A | Yellow | 30 | 11S | 8E | .132 | .010 | Same location as 27 |
| 28B | Yellow | 30 | 11S | 8E | .080 | .007 | Same location as 27 |
| 28C | Yellow | 30 | 11S | 8E | .125 | .005 | Same location as 27 |
| 29 | Red | 30 | 11S | 8E | .015 | .006 | Bulldozer trench |
| 30A | Red and yellow | 30 | 11S | 8E | .081 | .018 | Bulldozer trench |
| 30B | Red and yellow | 30 | 11S | 8E | .077 | .023 | Bulldozer trench |
| 31 | Red | 30 | 11S | 8E | .016 | | Test pit |
| 32A | Red | 30 | 11S | 8E | .016 | .002 | Test pit |
| 32B | Red | 30 | 11S | 8E | .027 | .006 | Test pit |
| 33 | Red | 25 | 11S | 7E | .007 | | Road cut |
| 34 | Red | 25 | 11S | 7E | .000 | | Bank of gully |
| 35 | Red | 25 | 11S | 7E | .002 | | Bank of gully |
| 38 | Red | 25 | 11S | 7E | .003 | | Bank of gully |
| 39 | Red | 25 | 11S | 7E | .013 | | Bank of creek |
| 40 | Red | 30 | 11S | 8E | .013 | | Bank of creek |
| 41 | Gray | 30 | 11S | 8E | .027 | .002 | Bulldozer trench |

Table 1. - (continued)

| Sample No. | Material | Location sec. | T. | R. | Analyses % eU | % $U_3O_8$ | Remarks |
|---|---|---|---|---|---|---|---|
| | Clays | | | | | | |
| 42 | Red | 31 | 11S | 8E | .014 | | Bulldozer trench |
| 43 | Red | 31 | 11S | 8E | .002 | | Bank of gully |
| 44 | Red | 31 | 11S | 8E | .003 | | Bank of gully |
| 46 | Red | 31 | 11S | 8E | .006 | | Road cut |
| 47 | Red | 30 | 11S | 8E | .007 | | Bank of creek |
| 48 | Red | 30 | 11S | 8E | .000 | | Bank of gully |
| 49 | Red | 30 | 11S | 8E | .002 | | On New Albany shale |
| 51 | Red | 30 | 11S | 8E | .003 | | Bank of creek |
| 52 | Brown | 30 | 11S | 8E | .016 | .004 | 2 feet below surface (1" auger hole) |
| 72E | Yellow | 30 | 11S | 8E | .155 | .014 | Bulldozer trench |
| 72E | Yellow | | | | .251 | .019 | -2 micron fraction |
| 78 | Red | 19 | 11S | 8E | .002 | | Road cut |
| 79 | Red | 30 | 11S | 8E | .003 | | Road cut |
| 80 | Red | 30 | 11S | 8E | .000 | | 1 foot below surface |
| 81 | Red | 24 | 11S | 7E | .019 | .007 | Road cut |
| 82 | Red | 25 | 11S | 7E | .000 | | Abandoned rock quarry |
| 84 | Yellow | 25 | 11S | 7E | .001 | | Abandoned rock quarry |
| 86 | Red | 25 | 11S | 7E | .000 | | Road cut |
| 87 | Red | 30 | 11S | 8E | .000 | | Creek bank |
| 89 | Brown | 25 | 11S | 7E | .002 | | Road cut |
| 93 | Red | 25 | 11S | 7E | .002 | | Creek bank |
| 94 | Red | 30 | 11S | 8E | .004 | | Road cut |
| 95 | Red | 29 | 11S | 8E | .002 | | Road cut |
| 96 | Red | 29 | 11S | 8E | .003 | | Road cut |
| 97 | Red | 29 | 11S | 8E | .002 | | Road cut |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 103 | Red | 31 | 11S | 8E | .000 | | Creek bank |
| 104 | Red | 36 | 11S | 7E | .001 | | Gully bank |
| 105 | Red | 36 | 11S | 7E | .001 | | Road cut |
| 106 | Red | 36 | 11S | 7E | .000 | | Road cut |
| 107 | Red | 36 | 11S | 7E | .002 | | Road cut |
| 108 | Red | 31 | 11S | 8E | .001 | | Road cut |
| 112 | Red | 31 | 11S | 8E | .001 | | Creek bank |
| 114 | Red | 25 | 11S | 7E | .003 | | Roadside ditch |
| 116 | Red | 31 | 11S | 8E | .004 | | Stream cut |
| 118 | Red | 31 | 11S | 8E | .002 | | 1 foot below road bed |
| 119 | Red | 31 | 11S | 8E | .003 | | Gully bank |
| 120 | Red | 32 | 11S | 8E | .000 | | 1 foot below road bed |
| 122 | Red | 30 | 11S | 8E | .007 | | 1 foot below surface |
| 123 | Red | 30 | 11S | 8E | .009 | | Creek bank |
| 124 | Yellow | 30 | 11S | 8E | .029 | .006 | Creek bank |
| 129 | Yellow and red | 30 | 11S | 8E | .048 | .013 | 1 foot below surface |
| 131 | Yellow and red | 30 | 11S | 8E | .002 | | Bulldozer trench |
| 132 | Yellow and red | 25 | 11S | 7E | .002 | | Test pit |
| 133 | Yellow and red | 25 | 11S | 7E | .001 | | Stream cut |
| 164 | Red | 25 | 11S | 7E | .006 | | Stream cut |
| 165 | Yellow | 25 | 11S | 7E | .005 | | Stream cut |
| 166 | Red and yellow | 25 | 11S | 7E | .000 | | Bulldozer trench |
| 167 | Yellow | 25 | 11S | 7E | .000 | | From trench of 164 |
| 168 | Yellow | 25 | 11S | 7E | .010 | | From trench 300' SW of 164 |
| 174 | Red | 25 | 11S | 7E | .034 | | From trench 300' SW of 164 |
| 175 | Yellow | 29 | 11S | 8E | .003 | | Bottom of trench of 166 |
| 176 | Red and yellow | 30 | 11S | 8E | .072 | | Road cut |
| | | 30 | 11S | 8E | .012 | | From trench |
| | | | | | | | From trench of 175 |
| | Silica Rocks | | | | | | |
| 1 | Chert breccia | 30 | 11S | 8E | .004 | | Test pit |
| 2 | Chert breccia | 30 | 11S | 8E | .006 | | Test pit |
| 3 | Chert breccia | 30 | 11S | 8E | .018 | .002 | Test pit |
| 4 | Chert breccia | 30 | 11S | 8E | .003 | | Test pit |

Table 1. - (continued)

| Sample No. | Material | Location sec. | T. | R. | Analyses % eU | % $U_3O_8$ | Remarks |
|---|---|---|---|---|---|---|---|
| | Silica Rocks | | | | | | |
| 5 | Chert breccia | 30 | 11S | 8E | .006 | | Test pit |
| 6 | Chert breccia | 30 | 11S | 8E | .030 | .004 | Test pit |
| 7 | Chert breccia | 30 | 11S | 8E | .008 | | Boulder in gully |
| 8 | Chert breccia | 30 | 11S | 8E | .005 | | Boulder in gully |
| 9 | Chert breccia | 30 | 11S | 8E | .007 | | Boulder on hillside |
| 10 | Chert breccia | 25 | 11S | 7E | .008 | | Breccia wall on hill |
| 11 | Chert breccia | 25 | 11S | 7E | .001 | | Same location as 10 |
| 12 | Chert breccia | 30 | 11S | 8E | .019 | .006 | Boulder in gully |
| 25 | Chert breccia | 25 | 11S | 7E | .006 | | In Osage formation |
| 26 | Chert breccia | 30 | 11S | 8E | .006 | | From bulldozer trench |
| 71 | Chert breccia | 25 | 11S | 7E | .004 | | Same as 25 |
| 72A | Chert | 30 | 11S | 8E | .003 | | Bulldozer trench |
| 72B | Chert | 30 | 11S | 8E | .006 | | Bulldozer trench |
| 72C | Chert | 30 | 11S | 8E | .000 | | Bulldozer trench |
| 72D | Soft weathered chert | 30 | 11S | 8E | .061 | .002 | Bulldozer trench |
| 75 | Chert breccia | 30 | 11S | 8E | .006 | | Test pit |
| 77 | Chert breccia | 30 | 11S | 8E | .014 | .006 | Test pit |
| 83 | Chert | 25 | 11S | 7E | .002 | | Abandoned rock quarry |
| 85 | Chert | 25 | 11S | 7E | .001 | | Abandoned rock quarry |
| 88 | Sandstone | 30 | 11S | 8E | .000 | | Surface of ground |
| 90 | Chert breccia | 25 | 11S | 7E | .004 | | Stream bank |
| 91 | Chert | 25 | 11S | 7E | .000 | | Stream cut |
| 113 | Chert breccia | 25 | 11S | 7E | .000 | | Surface |
| 121 | Chert breccia | 30 | 11S | 8E | .007 | | Test pit |
| 126 | Chert breccia | 36 | 11S | 7E | .006 | | Road cut |
| 127 | Chert breccia | 29 | 11S | 8E | .000 | | Surface of ground |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | Boulder |
| [illegible] | Explosion breccia | 30 | 11S | 8E | .005 | | Surface outcrop |
| 117 | Explosion breccia | 31 | 11S | 8E | .000 | | Surface outcrop |
| 125 | Explosion breccia | 30 | 11S | 8E | .008 | | Surface outcrop |
| 128 | Explosion breccia | 30 | 11S | 8E | .006 | | Surface outcrop |
| | Shale | | | | | | |
| 70A | New Albany formation | 25 | 11S | 7E | .005 | | Outcrop in creek |
| 70B | New Albany formation | 25 | 11S | 7E | .010 | | Outcrop in creek |
| 70C | New Albany formation | 25 | 11S | 7E | .024 | .007 | Outcrop in creek |
| 70D | New Albany formation | 25 | 11S | 7E | .022 | .005 | Outcrop in creek |
| 70E | New Albany formation | 25 | 11S | 7E | .022 | .007 | Outcrop in creek |
| 115 | New Albany formation | 31 | 11S | 8E | .006 | | Brecciated zone in stream |
| 73 | Osage shale | 25 | 11S | 8E | .002 | | Greenish shale over New Albany |
| | Miscellaneous | | | | | | |
| 45 | Limonite boulder | 31 | 11S | 8E | .008 | | At old prospect |
| 92 | Calcite and fluorite | 25 | 11S | 7E | .004 | | Stream float |

Table 2. - Size Analysis of Three Clays from Hicks Dome Area

| Sample | Location | | | Character of bulk sample particle size (wt. percent) | | | | Percent eU of size fractions | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | sec. | T. | R. | +60 | -60 +325 | -325 +2$\mu$ | -2$\mu$ (clay) | +60 | -60 +325 | -325 +2$\mu$ | -2$\mu$ | |
| U18 | 25 | 11S | 7E | 10.7 | 12.9 | 17.06 | 59.30 | .003 | .004 | .014 | .018 | Red clay |
| U38 | 25 | 11S | 7E | 64.24 | 2.91 | 18.81 | 13.95 | .005 | .006 | .009 | .012 | Red clay |
| U72e | 30 | 11S | 8E | 27.67 | 13.91 | 34.59 | 23.83 | .076 | .063 | .086 | .217 | Yellow silty clay |

Table 3. - Results of Tests on Samples Outside Map Area (Fig. 1)

(Analyses by L. D. McVicker, Geochemical Section, Illinois State Geol. Survey)

| Sample No. | Material | Location 1/4 | 1/4 | 1/4 | sec. | T. | R. | Near | % eU | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Clays | | | | | | | | | |
| 134 | Yellow | NE | SE | NW | 14 | 11S | 7E | Herod | .006 | Roadcut, N. side |
| 135 | Yellow | NE | SE | NW | 14 | 11S | 7E | Herod | .003 | Roadcut, S. side |
| 158 | Yellow | NE | SE | NW | 14 | 11S | 7E | Herod | .037 | 6" zone at top of shale |
| 159 | Yellow | NE | SE | NW | 14 | 11S | 7E | Herod | .029 | 1" zone overlying 158 |
| 160 | Green shale | NE | SE | NW | 14 | 11S | 7E | Herod | .005 | Shale bedrock under 158 |
| 161 | Red and yellow | SE | SE | NW | 14 | 11S | 7E | Herod | .050 | Wall of trench |
| 162 | Red | SE | SE | NW | 14 | 11S | 7E | Herod | .563* | 1/2" vertical "veins" in 161 |
| 110 | Red | NW | SE | SE | 23 | 11S | 7E | Hicks | .003 | Over dike of 109 |
| 169 | Red | NW | NW | SE | 23 | 11S | 7E | Hicks | .010 | Stream bank near spar prospect |
| 62 | Red | SE | SE | NE | 10 | 11S | 8E | Karbers Ridge | .000 | Roadcut, Hardinsburg sandstone |
| 58 | Red | NE | NE | NE | 13 | 11S | 8E | Sparks Hill | .000 | Over Sparks Hill breccia |
| 59 | Red | NE | NE | NE | 13 | 11S | 8E | Sparks Hill | .007 | 50' W. from 58 |
| 60 | Red | NE | NE | NE | 13 | 11S | 8E | Sparks Hill | .007 | 75' W. from 59 |
| 170 | Red | NE | NE | NE | 13 | 11S | 8E | Sparks Hill | .000 | 100' N. of 58 |
| 171 | Red | NE | NE | NE | 13 | 11S | 8E | Sparks Hill | .005 | 100' W. of 170 |
| 172 | Red | NE | NE | NE | 13 | 11S | 8E | Sparks Hill | .000 | 100' W. of 171 |
| 173 | Red | NE | NE | NE | 13 | 11S | 8S | Sparks Hill | .000 | 20' NNE. of 170 |
| 63 | Red | NW | NW | SE | 11 | 12S | 7E | Eichorn | .000 | Over sandstone, schoolyard |
| 64 | Red | NW | NE | SW | 14 | 12S | 7E | Humm's Wye | .004 | Near Stewart fault |
| 53 | Red | NE | NE | SE | 14 | 12S | 8E | Elizabethtown | .001 | Roadcut, Rt. 146 |
| 68 | Red | NW | NE | SW | 31 | 12S | 8E | Rosiclare | .000 | Over Soward breccia |
| 69 | Yellow | NW | NE | SW | 31 | 12S | 8E | Rosiclare | .000 | Over Soward breccia |
| 163 | Red | NW | NE | SW | 31 | 12S | 8E | Rosiclare | .004 | 100' N. of 68 |

*Percent $U_3O_8$, .010.

Table 3. - (continued)

| Sample No. | Material | Location 1/4 | 1/4 | 1/4 | sec. | T. | R. | Near | % eU | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Clays | | | | | | | | | |
| 65 | Red | NW | NW | SE | 32 | 12S | 8E | Rosiclare | .000 | Cave-in, Rosiclare vein system |
| 66 | Red | SE | SW | NE | 32 | 12S | 8E | Rosiclare | .007 | Cave-in, Rosiclare vein system |
| 54 | Green | SE | NE | SW | 7 | 12S | 9E | Elizabethtown | .008 | Shale from Peters Creek fault |
| 55 | Red | SE | NE | SW | 7 | 12S | 9E | Elizabethtown | .007 | From ss. in Peters Creek fault |
| 56 | Red | SE | NE | SW | 7 | 12S | 9E | Elizabethtown | .001 | From ls. in Peters Creek fault |
| | Igneous Rocks | | | | | | | | | |
| 151 | Peridotite dike | | | SE | 34 | 9S | 4E | Absher, Williamson Co. | .003 | Exposure in strip pit |
| 152 | Peridotite dike, weathered | | | SE | 34 | 9S | 4E | Absher, Williamson Co. | .000 | Exposure in strip pit |
| 153 | Coke at dike contact | | | SE | 34 | 9S | 4E | Absher, Williamson Co. | .000 | Exposure in strip pit |
| 109 | Peridotite dike | NW | SE | SE | 23 | 11S | 7E | Hicks | .009 | Stream cut, 300' W. of Rt. 34 |
| 154 | Peridotite dike | NW | SE | SE | 23 | 11S | 7E | Hicks | .021* | Same dike as 109 |
| 155 | Limestone from dike contact (154) | NW | SE | SE | 23 | 11S | 7E | Hicks | .000 | Dark dense limestone |
| 156 | Limestone inclusions from dike (154) | NW | SE | SE | 23 | 11S | 7E | Hicks | .011 | Dark dense limestone |
| 148 | Peridotite dike | | SE | SW | 32 | 12S | 8E | | .011 | Underground, Rosiclare vein system |
| 149 | Peridotite dike | | SW | NE | 25 | 13S | 6E | Golconda | .000 | Boulders |
| 150 | Peridotite sill, Downeys Bluff | | NW | SE | 5 | 13S | 8E | Rosiclare | .000 | Surface outcrop |
| 57 | Explosion breccia, Sparks Hill plug | NE | NE | NE | 13 | 11S | 8E | Sparks Hill | .007 | Surface outcrop |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | .004 | Surface outcrop |
| | Grant Intrusive | SE | NW | NW | 6 | 12S | 8E | Eichorn | | |
| 67 | Explosion breccia, | | | | | | | | .001 | Surface outcrop |
| | Soward Farm | NW | NE | SW | 31 | 12S | 8E | Rosiclare | | |
| 145 | Explosion breccia, | | | | | | | | .001 | Surface outcrop |
| | Soward Farm | NW | NE | SW | 31 | 12S | 8E | Rosiclare | | |
| 146 | Explosion breccia, | | | | | | | | .003 | Surface outcrop |
| | Soward Farm | NW | NE | SW | 31 | 12S | 8E | Rosiclare | | |
| | Miscellaneous | | | | | | | | .000 | Surface outcrop |
| 111 | Calcite veins | NW | SE | SE | 23 | 11S | 7E | Hicks | | |
| 20 | Zinc ore | SE | SE | SW | 27 | 11S | 7E | Eichorn | .000 | In limestone near dike 109 |
| 21 | Zinc ore | SE | SE | SW | 27 | 11S | 7E | Eichorn | .001 | Empire vein |
| 22 | Zinc ore | SE | SE | SW | 27 | 11S | 7E | Eichorn | .000 | Empire vein |
| 23 | Fluorspar | NW | NE | SW | 34 | 11S | 7E | Eichorn | .005 | Empire vein |
| 136 | Spar flotation conc. | | | | | | | Rosiclare | .000 | Douglas vein |
| 137 | Spar flotation conc. | | | | | | | Cave in Rock | .000 | Rosiclare vein |
| 138 | Spar flotation conc. | | | | | | | Cave in Rock | .000 | Bedded deposit |
| 139 | Lead, jig concentrate | | | | | | | Rosiclare | .000 | Bedded deposit |
| 140 | Sphalerite, flotation conc. | | | | | | | | .000 | |
| 141 | Galena, flotation conc. | | | | | | | Cave in Rock | .000 | Bedded deposit |
| 142 | Sphalerite, flotation conc. | | | | | | | Cave in Rock | .000 | Bedded deposit |
| 61 | Shale, spar prospect | | | | | | | Cave in Rock | .000 | Bedded deposit |
| | dump | NE | SW | SE | 12 | 11S | 8E | Sparks Hill | .008 | Upper Mississippian age |

*Percent $U_3O_8$, .013.

Table 4. - Summary of Data for Samples within the Devonian-New Albany Area

| Material | Uranium equivalent No. samples | Range | Av. | $U_3O_8$ No. samples | Range | Av. |
|---|---|---|---|---|---|---|
| Red clay | 37 | .000-.144 | .011 | 8 | .002-.014 | .006 |
| Yellow clay | 5 | .048-.155 | .108 | 5 | .005-.014 | .010 |
| Red and yellow clay | 2 | | .079 | 2 | | .020 |
| Gray clay | 1 | | .027 | 1 | | .002 |
| Black shale | 6 | .005-.024 | .015 | 3 | .005-.007 | .006 |
| Chert | 4 | .000-.061 | .018 | 1 | | .002 |
| Chert breccia | 14 | .004-.030 | .010 | 4 | .002-.006 | .005 |
| Explosion breccia | 3 | .002-.008 | .005 | | | |
| Peridotite dike | 1 | | .003 | | | |
| Limonite | 1 | | .008 | | | |

Table 5. - Summary of Analyses of Samples outside the Devonian-New Albany Area

| Material | Uranium equivalent | | | $U_3O_8$ | | |
|---|---|---|---|---|---|---|
| | No. samples | Range | Av. | No. samples | Range | Av. |
| Red clay* | 43 | .000-.019 | .003 | | | |
| Yellow clay | 10 | .000-.072 | .019 | | | |
| Red and yellow clay | 7 | .000-.050 | .010 | | | |
| Black shale | 1 | | .008 | | | |
| Green shale | 3 | .002-.008 | .005 | | | |
| Chert | 3 | .000-.002 | .001 | | | |
| Chert breccia | 8 | .000-.008 | .004 | | | |
| Explosion breccia | 10 | .000-.007 | .002 | | | |
| Peridotite dike | 8 | .000-.021 | .006 | 1 | | .013 |
| Fluorspar ore | 1 | | .000 | | | |
| Zinc ore | 3 | .000-.005 | .002 | | | |
| Fluorspar concentrate | 3 | | .000 | | | |
| Zinc concentrate | 2 | | .000 | | | |
| Lead concentrate | 2 | | .000 | | | |

*Omitting sample 162, which was so high as to distort other data.

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