IMN 44

ILLINOIS STATE GEOLOGICAL SURVEY

John C. Frye, Chief Urbana, Illinois 61801

November 1970

INDUSTRIAL MINERALS NOTES 44

ANALYSES OF SOME ILLINOIS ROCKS FOR GOLD

J. C. Bradbury, N. C. Hester, and R. R. Ruch

ABSTRACT

In order to provide information on possible sources of gold, a metal in short supply, the Illinois State Geological Survey has initiated a program of analyzing certain Illinois rocks for their gold content. Neutron activation, an extremely sensitive and relatively rapid method of analysis, was chosen as the most practicable assaying tool. Materials tested to date include glacially derived silts, sands, and gravels; peats, sandstones, and black shales. Gold was not positively identified in any of the samples. Further testing of sands and gravels is planned.

ANALYSES OF SOME ILLINOIS ROCKS FOR GOLD

J. C. Bradbury, N. C. Hester, and R. R. Ruch

INTRODUCTION

Following its long-established practice of providing information on present and potential mineral resources of Illinois and recognizing the ever-increasing gap between the production of gold in United States mines and the demand for it in industry and the arts, the Illinois State Geological Survey has initiated a program of analyzing certain earth materials within the state for gold. As the potential for commercial gold deposits in Illinois appears to be small, it was not deemed expedient to launch a full-scale sampling and assaying program. The approach that seemed best suited to the conditions was that of analyzing samples from our files and materials that were collected in conjunction with other field projects. In order to limit the number of samples for analysis, it was decided to test only those rock types that, for one reason or another, appeared to have some potential for commercial concentrations of gold. The results, discussed in the following paragraphs, constitute a progress report; further results from the analytical program for gold will be released from time to time.

MATERIALS TESTED

On the basis of geologic knowledge of gold occurrence and from the records of known and reported gold finds in Illinois and adjacent states over the past 100 years or so, it was concluded that the most promising materials for investigation were the sands and gravels associated with the glacial deposits. Black shales have been reported to contain abnormal amounts of gold; therefore, a representative sampling of this type of rock in Illinois for gold analysis also appeared worthwhile. Other types of materials analyzed were sandstones, alluvial sands, lake silts, and peat.

ANALYTICAL PROCEDURE

The analysis for gold was performed by employing neutron activation, an ultrasensitive technique of analysis for various elements such as gold, manganese, vanadium, sodium, europium, dysprosium, indium, and many others. A review of the theory of this technique and the application of it to various geologic problems has been published by Ruch, 1968.

From 1.0 to 1.5 grams of sample were accurately weighed and were then irradiated at the University of Illinois TRIGA II nuclear reactor for half an hour at full power (5×10^{12} neutrons per cm^2 per second) with a comparator gold standard. During irradiation, both the samples and the gold standard were placed in a rotary rack to insure equal neutron flux. After about four to five days' decay, the samples were transferred to unirradiated vials and counted directly above a 3" x 3" NaI detector connected to an RIDL 34-27 400-channel gamma-ray analyzer. The 0.411 meV gamma ray photopeak associated with radioactive ^{198}Au was used to quantitatively estimate the amount of gold in each sample by comparing it with the photopeak of a known standard similarly irradiated and counted.

Normally, without any spectral interference, radioactive gold may be detected down to a level of a few nanograms (10^{-9} grams). The geologic matrix associated with the sample places serious limitations on the attainment of this sensitivity. However, depending upon the sample size and the amount of interfering ^{140}La radioactivity present, it was possible to obtain in a sample practical sensitivities of 0.1 to 1 micrograms (10^{-6} grams) for gold. For the purpose of this study, to determine if economic concentrations exist in Illinois materials, this sensitivity was considered sufficient. Recently a chemical procedure has been developed which separates the radioactive gold from the geologic matrix and increases the detectable limit (Ruch, 1970) so that these non-economic nanogram amounts could quantitatively be determined, if desired.

The values reported (tables 1, 2, and 4) are stated as "less than" (<) or "equal to or less than" (≤). The (<) value should be interpreted to mean that no photopeak corresponding to that of ^{198}Au was discernible and that gold was not present in the sample up to the numerical value placed on the sample. If the background radiation from the sample is extremely high, a higher limit will be reported.

A (≤) value implies that a photopeak "possibly" corresponding to that produced by ^{198}Au was detected; however, there was insufficient evidence to positively confirm the peak as ^{198}Au. This uncertainty occurs when there are high photopeaks adjacent to the gold photopeak. In these cases, confirming evidence such as a correct 2.7 day decay time is almost impossible. Thus the data (table 4) should be interpreted to mean that gold is only possibly present at the amount stated, but it may not be there at all. It is not to be interpreted as definitely being present. It is possible that the observed photopeak was due to some other element.

Lack of positive detection of gold does not mean that gold would go undetected. For example, in a sample reported as < 0.5 ppm, certainly a 1 to 2 ppm gold content would have been detected, if present. In all samples, levels of 2 to 5 ppm would always be detectable without any problem.

BEDROCK STRATA

Black Shale

Samples of shale for gold assay were chosen from black carbonaceous shale samples that had been collected for uranium and oil shale studies (Ostrom et al., 1955; Lamar et al., 1956; Armon and Rees, 1960). Most of the samples came from strata of Pennsylvanian age, with the remainder about equally divided among Chesterian (Upper Mississippian), Kinderhookian (Lower Mississippian), and the New Albany Shale Group of Devonian-Mississippian age; the samples reflect approximately the geographic extent of exposures of each of these geologic units within Illinois. A few samples of the Maquoketa Shale Group of Ordovician age, although not a carbonaceous shale unit, were included to complete representation of thick shale formations that are exposed in Illinois.

For the present study, samples having various characteristics that might be considered favorable for gold concentration were chosen for analysis.

The primary criterion to be tested was color (as an indicator of carbon or hydrocarbon content); therefore, an initial selection of 20 samples was made to include only black (not dark gray) shales, chosen to provide both stratigraphic and geographic distribution. An additional set of 18 samples was chosen on the basis of other criteria, such as a relatively high radiation count (Ostrom et al., 1955) or a moderately high to high oil yield (Lamar et al., 1956, and Armon and Rees, 1960).

Results of analyses are shown in table 1. It will be noted that gold was not detected in any of the samples; the numerical values listed represent only the lower limits of detection for the respective samples. It is, therefore, concluded that Illinois black shales, as a type of rock, are not promising as a source of gold.

Sandstone

In the early stages of the gold investigation, various rock types in Survey files were assayed with no attempt at a statistical representation of each rock type. Three samples of sandstone of Pennsylvanian age were submitted for neutron activation analysis. Gold was not detected in any of the three (table 2; lithologic descriptions of these three samples may be found in Bradbury et al., 1962). As in table 1, the numerical values reported in table 2 represent the lower limits of detection. Although these three analyses are not considered statistically significant to the question of favorability of Pennsylvanian sandstones as host rocks for detrital gold, the results are included here as a part of the body of gold assay data on Illinois rocks.

TABLE 1—SHALE ANALYSES

County	Sample number*	Location Sec.	T.	R.	Thickness (in.)	Au (ppm)**	Color††	% eU***	Oil (gpt)†	System or Series
Calhoun	A-34	35	9S	3W	60	n.d. (< 0.20)		.007	none	Kinderhookian#
	A-35	17	11S	2W	60	n.d. (< 0.16)		.002		Ordovician
	A-36	17	11S	2W	60	n.d. (< 0.18)		.001		Ordovician
Clark	D-89	20	11N	10W	33	n.d. (< 0.18)	Black	.009	7.5	Pennsylvanian
Fulton	0-739	20	8N	3E	32	n.d. (< 0.17)	Black		12.9	Pennsylvanian
Hardin	M-3	25	11S	7E	60	n.d. (< 0.17)	Black	.003	none	
	M-4	25	11S	7E	60	n.d. (< 0.17)	Black	.014	trace	Devonian - Mississippian
	M-5	25	11S	7E	60	n.d. (< 0.20)	Black	.009	trace	
Henry	D-45	33	14N	1E		n.d. (< 0.06)	Black	.004	40.1	Pennsylvanian
Jefferson	D-16	22	1S	3E	15	n.d. (< 0.26)	Black	.011	4.2	Pen sylvanian
	D-19	13	3S	3E	12	n.d. (< 0.10)	Black	.000	36.4	Pennsylvanian
Jersey	A-37	4	6N	12W	60	n.d. (< 0.18)		.008		Kinderhookian#
	A-38	4	6N	12W	60	n.d. (< 0.16)		.007		Kinderhookian#
Johnson	D-36	33	11S	4E	27	n.d. (< 0.38)	Black	.012	11.2	Pennsylvanian
La Salle	D-56	8	32N	2E	22	n.d. (< 0.24)	Black	.008	25.8	Pennsylvanian
Macoupin	D-77a	12	7N	7W		n.d. (< 0.18)		.065		Pennsylvanian
Perry	0-740	25	5S	3W	34	n.d. (< 0.18)	Black		13.3	Pennsylvanian

* Numbers correspond to those in Ostrom et al. (1955), Lamar et al. (1956), and Armon and Rees (1960).

** ppm = parts per million; n.d. = not detected; values in ( ) represent limits of detection.

*** eU = equivalent uranium (total radioactivity expressed in terms of U_3O_8); from Ostrom et al. (1955).

† gpt = gallons per ton; from Lamar et al. (1956), and Armon and Rees (1960).

†† Blank indicates gray or dark gray.

Kinderhookian Series = Lower Mississippian; Chesterian Series = Upper Mississippian.

(Table continued on page 5)

TABLE 1—(Continued)

County	Sample number*	Location Sec.	T.	R.	Thickness (in.)	Au (ppm)**	Color††	% eU***	Oil (gpt)†	System or Series
Pike	A-44	17	6S	5W	60	n.d. (< 0.16)		.003	2.1	Devonian-Mississippian
	A-45	17	6S	5W	60	n.d. (< 0.17)		.008	2.1	Devonian-Mississippian
	A-42	24	7S	4W	60	n.d. (< 0.13)		.003		Kinderhookian#
Pope	A-30	30	12S	5E	60	n.d. (< 0.19)	Black	.008		Chesterian#
	A-31	30	12S	5E	60	n.d. (< 0.16)	Black	.006		Chesterian#
Randolph	A-1	32	7S	6W	60	n.d. (< 0.14)	Black	.006		Chesterian#
	A-2	32	7S	6W	60	n.d. (< 0.16)	Black	.007		Chesterian#
	A-5	33	7S	6W	30	n.d. (< 0.17)	Black	.004		Chesterian#
	A-6	33	7S	6W	48	n.d. (< 0.18)	Black	.003		Chesterian#
Rock Island	D-61AB	1	16N	5W	120	n.d. (< 0.17)	Black	.006		Pennsylvanian
	D-61CD	1	16N	5W	120	n.d. (< 0.18)	Black	.003		Pennsylvanian
	D-61EF	1	16N	5W	120	n.d. (< 0.15)	Black	.004		Pennsylvanian
Saline	D-24	30	10S	6E	10	n.d. (< 0.27)	Black	.016	none	Pennsylvanian
	D-27	30	10S	5E	35	n.d. (< 0.23)	Black	.013	8.9	Pennsylvanian
Sangamon	D-70	3	13N	5W	17	n.d. (< 0.24)	Black	.014	11.7	Pennsylvanian
Schuyler	D-68	36	2N	1W	38	n.d. (< 0.15)	Black	.011	17.6	Pennsylvanian
Union	A-12	34	11S	2W	60	n.d. (< 0.17)		.011	5.2	Devonian - Mississippian
Vermilion	D-5	4	19N	12W	17	n.d. (< 0.19)		.002		Pennsylvanian
Williamson	D-6a	28	9S	4E	9	n.d. (< 0.17)	Black	.011	18.0	Pennsylvanian
	D-35	22	10S	4E		n.d. (< 0.27)	Black	.012	trace	Pennsylvanian
	D-29	30	10S	4E	18	n.d. (< 0.15)	Black	.002	trace	Pennsylvanian

* Numbers correspond to those in Ostrom et al. (1955), Lamar et al. (1956), and Armon and Rees (1960).

** ppm = parts per million; n.d. = not detected; values in ( ) represent limits of detection.

*** eU = equivalent uranium (total radioactivity expressed in terms of U_3O_8); from Ostrom et al. (1955).

† gpt = gallons per ton; from Lamar et al. (1956), and Armon and Rees (1960).

†† Blank indicates gray or dark gray.

Kinderhookian Series = Lower Mississippian; Chesterian Series = Upper Mississippian.

TABLE 2—ANALYSES OF PENNSYLVANIAN SANDSTONE FOR GOLD

Sample number*	County	Location Sec.	T.	R.	Formation (Member)	Au(ppm)†
M-39	La Salle	23	31N	3E	Carbondale (Vermilionville)	n.d. (< 0.05)
B-3	Montgomery	25	9N	5W	Bond (McWain)	n.d. (< 0.12)
B-18	Randolph	13	5S	7W	Caseyville	n.d. (< 0.02)

* Numbers correspond to those in Bradbury et al. (1962).
† ppm = parts per million; n.d. = not detected; values in ( ) represent limits of detection.

PLEISTOCENE DEPOSITS

Samples for analysis were collected from glacio-fluvial deposits in Macon, Sangamon, Logan, and Will counties; from glacio-fluvial and associated river bar deposits (Holocene) along the Wabash River in Clark and Crawford counties, Illinois, and Vigo County, Indiana; from lacustrine silts in Ford County; and from peat in Whiteside and Lake counties. These samples are listed and briefly described in table 3. Results of analyses are shown in table 4.

Glacio-Fluvial Deposits (Glacial Outwash)

The most promising earth materials within Illinois for the occurrence of recoverable gold are believed to be the glacial sands and gravels. Placer deposits in glacial outwash (or perhaps reworked outwash) were mined on a small scale in south central Indiana around 1900 (Blatchley, 1903), and scattered minor occurrences in sand and gravel have been reported from time to time in Illinois (Lamar, 1968).

Samples of sand and gravel for the present analytical program came, for the most part, from material collected from operating or abandoned pits and from outcrops of sand and gravel during sand and gravel resource studies. In addition, outwash was sampled solely for gold at several places along the Wabash River Valley and in Will County.

Samples Collected During Sand and Gravel Resource Studies

Channel samples were collected where possible. In those operating pits in which the materials occur below water level, the samples were taken from a bank-run stockpile recovered by dragline. All samples were dried and sieved, using a nest of screens with U. S. Standard number 230 (.063 mm) as the finest size. The fraction that passed the U. S. Standard number 60 (.25 mm) and was retained on the U. S. Standard number 230 was subjected to heavy mineral separation using bromoform (specific gravity 2.86). Although Clifton et al. (1967) suggest using a lower size limit of 0.038 mm, Tourtelot (1968) has found that gold of particle size less than 0.100 mm is difficult to recover, even with very careful panning. Therefore, considering that glacio-fluvial gold deposits are likely to be treated commercially by ordinary placer recovery methods, such as sluicing or other relatively gross washing procedures, the lower size limit of .063 mm would seem to be adequate for this study.

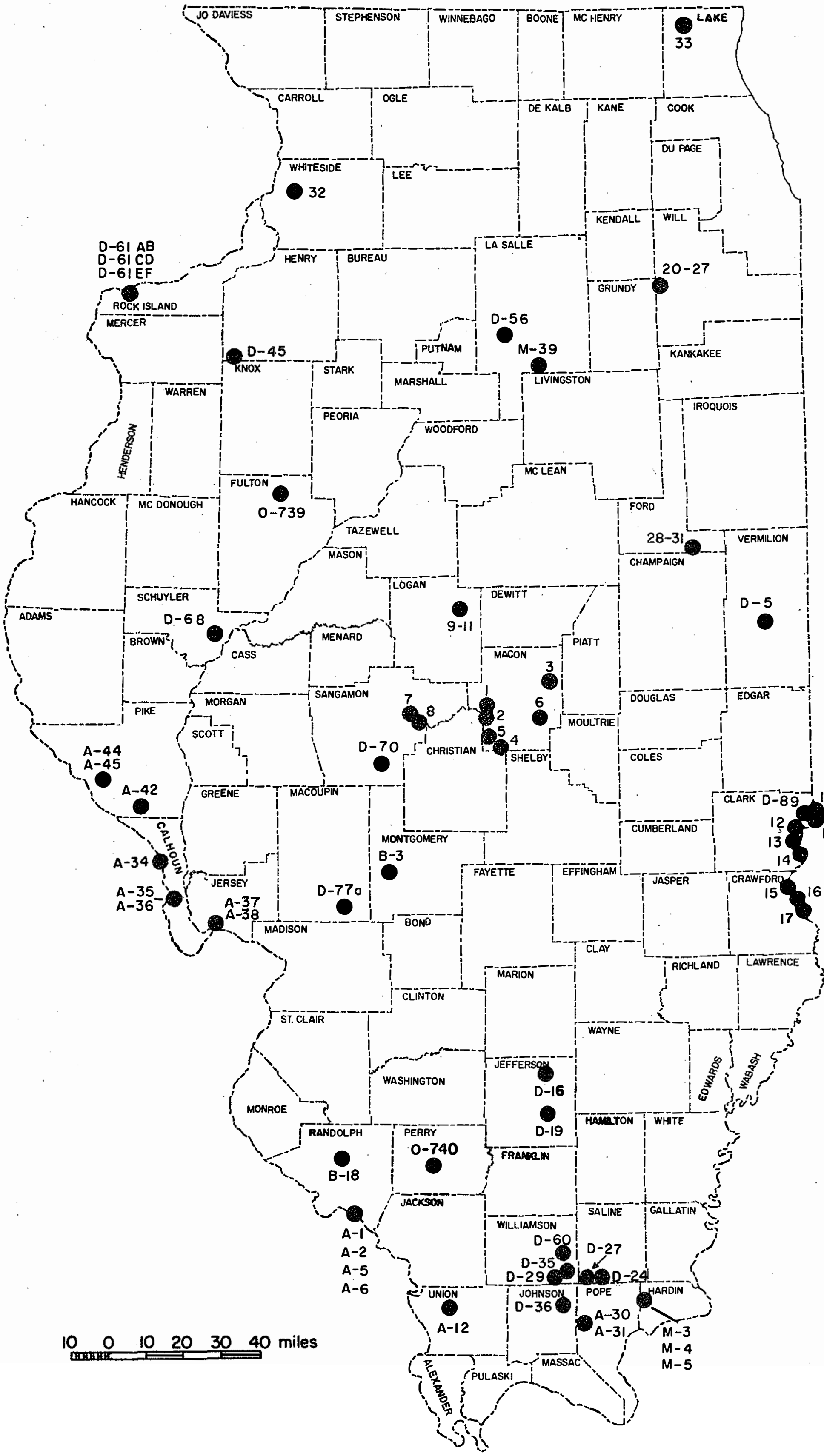

Fig. 1--Location map of samples for gold analysis.

Macon County. Samples from this county were collected from sand and gravel pits (samples 1 through 6, fig. 1). Samples 1 through 3 were taken on terrace remnants along the Sangamon River; sample 4 comes from the terrace along Willow Branch, sample 5 from the kame near Blue Mound and sample 6 from the sand and gravel below the Big Creek floodplain (Hester and Anderson, 1969).

Sangamon County. Two samples were taken from this county. Sample 7 was collected at a sand and gravel pit three miles downstream from Buckhart that is recovering sand and gravel from below the Sangamon River floodplain. Sample 8 comes from a sand and gravel operation in a terrace remnant along the Sangamon River near the town of Buckhart (Hester, 1970).

Logan County. Three samples (9, 10, and 11, table 3) were taken from three closely spaced exploration pits dug in the outwash plain south of Kickapoo Creek. The thickness of the sampled bed is unknown but is believed to be less than 10 feet.

Wabash River Valley

The Wabash River valley was chosen for investigation because 1) it represented a specific type of occurrence (major river valley) and 2) the heavy minerals of the sands and gravels present there had previously been studied (Hunter, 1966). The samples for the present study were taken to duplicate as closely as possible those collected by Hunter. Sample preparation procedures were the same as those described for samples taken during sand and gravel resource studies.

Clark County. Samples 12, 13, and 14 (table 3) were collected in this county along the Wabash River. Sample 12 was taken from a pit exposure in the high terrace (Hunter, sample locality 3), sample 13 was taken from a pit in the low terrace (Hunter, 4), and sample 14 came from a shallow trench in a Holocene Wabash River bar (Hunter, 5) composed of reworked glacial sand and gravel.

Crawford County. Samples 15 and 16 (table 3) were taken from pit exposures in the low terrace (Hunter, sample localities 7 and 8), and sample 17 was collected from a trench dug in a Holocene Wabash River bar consisting of reworked glacial sand and gravel (Hunter, 9).

Vigo County, Indiana. Two samples were collected along the Wabash River in Indiana. Sample 18 was taken from a pit exposure in the high terrace (Hunter, 1) and sample 19 comes from a trench dug in a Holocene Wabash River bar that consists of reworked glacial sand and gravel (Hunter, 2).

Will County Gold Prospect

A 1922 newspaper account of gold associated with outwash sand and gravel near Channahon was brought to our attention recently by one of the principals involved in the original find, located in the SE¼ NE¼ NW¼ sec. 8, T. 34 N., R. 9 E. With the cooperation of the present property owner, two pits were dug, one in the immediate vicinity of the 1922 find (supposedly within 10 feet), and the other about 200 feet from the first in a direction estimated to be about S20E. Both pits were sampled as indicated in the following logs. The surficial geology of the area is shown in Fisher (1927?).

Pit No. 1

Location: 100 feet north from NE corner of house, near center SE¼ NE¼ NW¼ sec. 8, T. 34 N., R. 9 E.

Material	Thickness
3. Black soil	1.5 ft
2. Silt, sandy, clayey	1.0 ft
1. Gravel, sandy, silty, clayey	2.5 ft
	Bottom of pit

Sample 20 from bed 2, west pit wall

Sample 21 from bed 1, west pit wall

Sample 22 from bed 2, southeast corner of pit

Sample 23 from bed 1, southeast corner of pit

Sample 27 from bed 2, west pit wall

Pit No. 2

Location: 90 feet S45E (approximately) from SE corner of house.

4. Black soil	1.0 ft
3. Silt, sandy, clayey (Sample 24)	0.7 ft
2. Gravel, dirty, like bed 1 of Pit No. 1 (Sample 25)	1.0 ft
1. Sand and gravel, clean (Sample 26)	3.0 ft

Sample Treatment. The samples were washed by settling and decantation to remove the very fine particle sizes (less than .031 mm). As separations were to be made by heavy liquids, it was felt that particles finer than this could not be easily processed. After drying, further size separations were made by screening, with the plus 4 mesh fraction discarded, the 4 x 8 and 8 x 35 mesh fractions examined under the binocular microscope for gold particles, and the minus 35 mesh portion subjected to heavy liquid separation in bromoform (specific gravity 2.8 to 2.9). The fraction that settled in the bromoform was then analyzed for gold by neutron activation.

Results. Microscopic examination of the 4 x 8 and 8 x 35 mesh portions revealed no gold in any of the samples. Results of neutron activation analyses of the heavy minerals are shown in table 4.

Discussion of Results - Glacial Outwash Samples

In none of the samples was gold positively detected (table 4). As stated in a previous section of this report (Analytical Procedure), the symbol ≤ (equal to or less than) implies that gold may be present up to the stated amount but that the actual presence of gold could not be confirmed. For the purposes of this study, however, the limits of detection achieved were sufficiently low that the question of whether or not gold is, in fact, present is of no practical interest. Because the samples assayed are heavy mineral concentrates that represent, generally, 1 to 3 percent of the original sample, the raw sand or gravel that would have to be mined and processed would contain, at best, 0.04 ppm gold (based on the highest possible assay, 1.3 ppm), too low a concentration to justify attempted recovery of the gold, even if only as a by-product of a sand and gravel operation.

Lacustrine Sediments (Fine Sand and Silt)

Gold was reported from an area in Ford County near Paxton, and samples of the reported gold-bearing material, lacustrine silt and fine sand, were given to the Survey for analysis. Under highly favorable conditions gold can be deposited with fine-grained sand and silt in commercial quantities, as for example, in sand and silt near American Falls, Idaho, along the Snake River (Antweiler and Love, 1969).

Because the gold reported from sediments with this size range (Antweiler and Love, 1969) is less than 100 microns, analyses were run on the heavy mineral separate between the U. S. Standard sieve sizes 60 (.25 mm) and 325 (.044 mm). Analyses were also run on the bulk sample.

<u>Results</u>. The analyses of these samples (27 through 30) appear in table 4. The highest number recorded, ≤ 0.31 ppm, is for the heavy mineral separate from sample 28. Even if this figure were assumed to be all gold, the amount for the total sample would range from approximately 32 to 62 parts per billion, which is commercially insignificant.

Peat

Organic-rich sediments have been reported to contain abnormal amounts of metals (Cannon, 1955; Fraser, 1961; Ong and Swanson, 1966); therefore, analyses were run on samples from the two major peat localities in the state (Hester and Lamar, 1969). Sample preparation consisted simply of crumbling the air-dried peat between the fingers.

<u>Whiteside County</u>. One sample (31) of bulk peat was analyzed from a locality west of Morrison. This material occurs as a filling in a cut-off of the ancient Mississippi River.

<u>Lake County</u>. One sample (32) of bulk peat was analyzed from a locality just north of Lake Villa. This material occurs as the filling of a lake.

<u>Results</u>. The analyses appear in table 4. No gold was detected.

TABLE 3—MATERIAL TYPE, AGE, TOPOGRAPHIC FORM, AND LOCATION BY COUNTY OF PLEISTOCENE SAMPLES FOR GOLD ANALYSIS

Sample number	Material	Age	Type of deposit	County
1	Sand and gravel	Wisconsinan	Terrace	Macon
2	Sand and gravel	Wisconsinan	Terrace	Macon
3	Sand and gravel	Wisconsinan	Terrace	Macon
4	Sand and gravel	Wisconsinan	Terrace	Macon
5	Sand and gravel	Illinoian	Kame	Macon
6	Sand and gravel	Wisconsinan	Floodplain	Macon
7	Sand and gravel	Wisconsinan	Floodplain	Sangamon
8	Sand and gravel	Wisconsinan	Terrace	Sangamon
9	Sand and gravel	Wisconsinan	Outwash plain	Logan
10	Sand and gravel	Wisconsinan	Outwash plain	Logan
11	Sand and gravel	Wisconsinan	Outwash plain	Logan
12	Sand and gravel	Wisconsinan	High terrace	Clark
13	Sand and gravel	Wisconsinan	Low terrace	Clark
14	Sand and gravel	Holocene	River bar	Clark
15	Sand and gravel	Wisconsinan	Low terrace	Crawford
16	Sand and gravel	Wisconsinan	Low terrace	Crawford
17	Sand and gravel	Holocene	River bar	Crawford
18	Sand and gravel	Wisconsinan	High terrace	Vigo County, Indiana
19	Sand and gravel	Holocene	River bar	Vigo County, Indiana
20	Silt and sand	Wisconsinan	Terrace	Will
21	Sand and gravel	Wisconsinan	Terrace	Will
22	Silt and sand	Wisconsinan	Terrace	Will
23	Sand and gravel	Wisconsinan	Terrace	Will
24	Silt and sand	Wisconsinan	Terrace	Will
25	Sand and gravel	Wisconsinan	Terrace	Will
26	Sand and gravel	Wisconsinan	Terrace	Will
27	Silt and sand	Wisconsinan	Terrace	Will
28	Silt and sand	Wisconsinan	Lacustrine	Ford
29	Silt and sand	Wisconsinan	Lacustrine	Ford
30	Silt and sand	Wisconsinan	Lacustrine	Ford
31	Silt and sand	Wisconsinan	Lacustrine	Ford
32	Peat	Wisconsinan	River fill	Whiteside
33	Peat	Wisconsinan	Lake fill	Lake

TABLE 4--GOLD ANALYSES OF PLEISTOCENE SEDIMENTS IN ILLINOIS

Sample number	Location ¼	¼	¼	Sec.	T.	R.	Au (ppm) in heavy mineral concentrates**	Thickness sampled (ft)
1	SE	SW	SE	29	16N	1E	≤ 0.2	dragline
2	NE	NE	SE	32	16N	1E	≤ 0.2	dragline
3	SW	NE	SE	18	14N	1E	≤ 0.6	4
4	NW	NE	NE	13	17N	4E	≤ 0.5	6
5	NE	NW	SW	31	15N	1E	≤ 0.3	9
6	SW	SW	NE	2	15N	3E	≤ 0.2	12
7	SW	SW	SW	36	16N	4W	≤ 0.12	dragline
8	SE	NE	SE	8	15N	3W	≤ 0.42	dragline
9	-	-	NE	7	20N	1W	≤ 0.54	?
10	-	-	NE	7	20N	1W	≤ 0.70	?
11	-	-	NE	7	20N	1W	≤ 0.49	?
12	NE	SW	SE	10	10N	11W	≤ 0.8	15
13	SW	NE	SE	28	10N	11W	≤ 0.9	6
14	NE	SW	NE	12	9N	11W	≤ 1.3	1
15	SW	SW	NE	33	8N	11W	≤ 0.5	5
16	SE	SE	SW	10	7N	11W	≤ 0.7	5
17	NW	NW	NW	18	7N	10W	≤ 0.5	1
18	NW	NE	SW	21	11N	10W	≤ 0.6	3
19	SW	SE	NW	28	11N	10W	≤ 0.6	2
20	SE	NE	NW	8	34N	9E	≤ 0.9	1
21	SE	NE	NW	8	34N	9E	n.d. (< 0.4)	2.5
22	SE	NE	NW	8	34N	9E	0.0*	1
23	SE	NE	NW	8	34N	9E	n.d. (< 0.6)	2.5
24	SE	NE	NW	8	34N	9E	n.d. (< 0.4)	0.7
25	SE	NE	NW	8	34N	9E	n.d. (< 0.5)	1
26	SE	NE	NW	8	34N	9E	n.d. (< 0.3)	3
27	SE	NE	NW	8	34N	9E	n.d. (< 0.2)†	1
28	-	SE	SE	29	23N	10E	n.d. (< 0.23)	?
29	-	SE	SE	29	23N	10E	≤ 0.31	?
30	-	SE	SE	29	23N	10E	n.d. (< 0.11)†	?
31	-	SE	SE	29	23N	10E	n.d. (< 0.09)†	?
32	SW	SE	SW	17	21N	4E	n.d. (< 0.01)†	3
33	SE	SE	SW	20	46N	10E	n.d. (< 0.02)†	3

** ppm = parts per million; n.d. = not detected; values in ( ) represent limits of detection; gold not positively identified in samples with analyses reported as ≤ (see text).

* Analysis by fire-assay

† Analysis run on whole sample

SUMMARY AND CONCLUSIONS

Analyses for gold in various types of earth materials found in Illinois were carried out by neutron activation, a relatively rapid and sensitive method of analysis for gold and certain other elements. Materials tested to date include 38 samples of black shale, 3 of sandstone, 27 of sand and gravel deposits, 4 of lacustrine silts, and 2 of peat.

No gold was detected in the black shales, and it was concluded that, as a rock type, Illinois black shales show little promise as a commercial source of gold.

The three samples of sandstone, likewise, showed no detectable gold. While analysis of three samples cannot be regarded as a statistically sound test of the gold-bearing possibilities of the rock type, Illinois sandstones are not believed to be likely host rocks for gold, and no further testing of sandstones for gold is planned.

Gold was not positively detected in the samples from glacial sand and gravel deposits and associated river alluvium. It is noteworthy that even if the recorded values were assumed to indicate gold, the amount of gold present in the original untreated samples would be much too small to be of commercial interest.

The remainder of the samples, four of lacustrine silts and two of peat, contained no detectable gold.

Because glacial sands and gravels are known to be gold-bearing in places in the upper Midwest, the program of testing these deposits will be continued. Samples for assaying are expected to come chiefly from sand and gravel resource studies or from other field projects concerned with sands and gravels.

REFERENCES

Antweiler, J. C., and J. D. Love, 1969, Fluvial transport of fine-grained gold: Geological Survey Research, 1969, U. S. Geol. Survey Prof. Paper 650 A, p. A-7.

Armon, W. J., and O. W. Rees, 1960, Chemical evaluation of Illinois oil shales: Illinois Geol. Survey Circ. 307, 22 p.

Blatchley, W. S., 1903, Gold and diamonds in Indiana: Reprinted from the 27th Annual Report of the Indiana Dept. of Geology and Natural Resources, p. 11-47.

Bradbury, J. C., M. E. Ostrom, and J. E. Lamar, 1962, Chemical and physical character of the Pennsylvanian sandstones in central Illinois: Illinois Geol. Survey Circ. 331, 43 p.

REFERENCES (Continued)

Cannon, H. L., 1955, Geochemical relations of zinc-bearing peat to the Lockport Dolomite, Orleans County, New York: U. S. Geol. Survey Bull. 1000-D, p. 119-185.

Clifton, H. E., Arthur Hubert, and R. L. Phillips, 1967, Marine sediment sample preparation for analysis for low concentrations of fine detrital gold: U. S. Geol. Survey Circ. 545, 11 p.

Fisher, D. J., 1927 (?), Geology and mineral resources of the Wilmington Quadrangle: Illinois Geol. Survey Open File Report DJF-3, 183 p.

Fraser, D. C., 1961, Organic sequestration of copper: Econ. Geol., v. 56, p. 1063-1078.

Hester, N. C., 1970, Sand and gravel resources of Sangamon County, Illinois: Illinois Geol. Survey Circ. 452, 20 p.

Hester, N. C., and R. C. Anderson, 1969, Sand and gravel resources of Macon County, Illinois: Illinois Geol. Survey Circ. 446, 16 p.

Hester, N. C., and J. E. Lamar, 1969, Peat and humus in Illinois: Illinois Geol. Survey Industrial Minerals Notes 37, 14 p.

Hunter, R. E., 1966, Heavy minerals in sands along the Wabash River: Illinois Geol. Survey Circ. 402, 24 p.

Lamar, J. E., 1968, Personal communication.

Lamar, J. E., W. J. Armon, and J. A. Simon, 1956, Illinois oil shales: Illinois Geol. Survey Circ. 208, 23 p.

Ong, H. L., and V. E. Swanson, 1966, Adsorption of copper by peat, lignite, and bituminous coal: Econ. Geol., v. 61, no. 7, p. 1214-1231.

Ostrom, M. E., M. E. Hopkins, W. A. White, and L. D. McVicker, 1955, Uranium in Illinois black shales: Illinois Geol. Survey Circ. 203, 15 p.

Ruch, R. R., 1968, Neutron activation analysis at the Illinois State Geological Survey: Illinois Geol. Survey Industrial Minerals Notes 34, p. 1-8.

Ruch, R. R., 1970, Radiochemical separation of gold by amalgam exchange: Analytica Chemica Acta, v. 49, p. 381-389.

Tourtelot, H. A., 1968, Fine-grained gold in sluice overflow: in U. S. Geological Survey heavy metals program progress report 1968-topical studies: U. S. Geol. Survey Circ. 622, p. 5-6.

INDUSTRIAL MINERALS NOTES SERIES

- * 1. Heavy Minerals in Illinois Glacial Sands. 1954.
- * 2. Lightweight Brick from Clay and Peat or Shredded Corncobs. 1955.
- * 3. (1) The Industrial Minerals Industry in Illinois in 1955. (2) Trace Elements and Potash in Some Illinois Gravels. 1956.
- * 4. Subsurface Dolomite in Lake, McHenry, and Part of Northwestern Cook Counties. 1956.
- * 5. (1) Gypsum and Anhydrite. (2) Fluorspar for Controlling Vanadium Staining. (3) Relation of Sulfate and Chloride to Ore Deposits in the Ordovician Rocks of Jo Daviess County. (4) Possibilities for Calcitic Limestone Underground in Kankakee and Iroquois Counties. 1957.
- 6. Trend in Fuel Uses in Selected Industrial Mineral Products, 1947 and 1954. 1957.
- * 7. Outlying Occurrences of Galena, Sphalerite, and Fluorite in Illinois. 1957.
- * 8. Origin of Illinois Sand and Gravel Deposits. 1958.
- * 9. Shales as Source Material for Synthetic Lightweight Aggregate. 1959.
- *10. Recent Price and Cost Trends Relating to Stone, Sand, and Gravel Production in Illinois. 1959.
- *11. Rare Earth and Trace Element Content of an Unusual Clay on Hicks Dome in Hardin County, Illinois. 1960.
- *12. A Survey of Some Illinois Materials Possibly Useful as Pozzolans. 1961.
- 13. Summary of Illinois Mineral Industry, 1951-1959. 1961.
- *14. Illinois Stone Production in 1959. 1961.
- *15. Black and Brown Terrazzo Chips from Southern Illinois Limestones. 1962.
- *16. Refractory Clay Resources of Illinois. 1962.
- 17. Pelletizing Illinois Fluorspar. 1963.
- *18. Permanent Expansion in Bricks. 1964.
- 19. Binding Materials Used in Making Pellets and Briquets. 1964.
- 20. Chemical Composition of Some Deep Limestones and Dolomites in Livingston County, Illinois. 1964.
- 21. Illinois Natural Resources--An Industrial Development Asset. 1964.
- *22. Illinois Clays as Binders for Iron Ore Pellets. 1965.
- 23. Limestone Resources of Jefferson and Marion Counties, Illinois. 1965.
- 24. Thermal Expansion of Certain Illinois Limestones. 1966.
- 25. Annotated Selected List of Industrial Minerals Publications. 1966.
- 26. Binders for Fluorspar Pellets. 1966.
- 27. High-Purity Limestones in Illinois. 1966.
- 28. Illinois Clays as Binders for Iron Ore Pellets—A Further Study. 1966
- 29. Clay and Shale Resources of Clark, Crawford, Cumberland, Edgar, Effingham, Jasper, and Vermilion Counties. 1967.
- 30. Lightweight Bricks Made with Clay and Expanded Plastic. 1967.
- 31. Clays as Binding Materials. 1967.
- 32. Silica Sand Briquets and Pellets as a Replacement for Quartzite. 1968.
- 33. A New Use for Illinois Clay Mateials in Pesticide Formulations. 1968.
- 34. Neutron Activation Analysis at the Illinois State Geological Survey. 1968.
- 35. Computer-Calculated Lambert Conformal Conic Projection Tables for Illinois (7.5-Minute Intersections). 1968.
- 36. Beneficiation of Kaolinite Clay from Silica Sand Washings. 1968.
- 37. Peat and Humus in Illinois. 1969.
- 38. Kankakee Dune Sands as a Commercial Source of Feldspar. 1969.
- 39. Alumina Content of Carbonate Rocks as an Index to Sodium Sulfate Soundness. 1969.
- 40. Colloidal-Size Silica Produced from Southern Illinois Tripoli. 1970.
- 41. Two-Dimensional Shape of Sand Made by Crushing Illinois Limestones of Different Textures. 1970.
- 42. An Investigation of Sands on the Uplands Adjacent to the Sangamon River Floodplain: Possibilities as a "Blend Sand" Resource. 1970.
- 43. Lower Mississippi River Terrace Sands as a Commercial Source of Feldspar. 1970.

* Out of print