MINERALOGY OF SUSPENDED SEDIMENT

IN

THE SCIOTO AND OLENTANGY RIVERS

by

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ABSTRACT

The mineralogy of suspended sediment in the Scioto and Olentangy Rivers was determined by x-ray diffraction methods. The mineralogy of the respective sediments from the two rivers reflects the bedrock lithology underlying each river quite well. The percentage of carbonate minerals was appreciably greater in the sediments of the Scioto River, while clay minerals are more abundant in the Olentangy River. Certain minerals may have been derived from the glacial overburden in this area. Talc was found to be the dominant constituent of the sediments in both rivers and its presence can be attributed to the use of pesticide powders in the drainage basin. Samples of pesticide powders were x-rayed for comparison with the sediment. Two (PHALTAN and BAYGON) showed a strong diffraction spectrum for talc, suggesting the distinct possibility that talc in the suspended sediment of the Olentangy and Scioto Rivers may be derived from pesticides.

INTRODUCTION

Throughout its course the Scioto River drains an area in which the bedrock is primarily limestone and dolomite (the Columbus and Delaware Limestones). The Olentangy River, on the other hand, drains an area which is underlain by the Ohio and Olentangy Shales. The drainage basins of both rivers are covered by a thin veneer of glacial overburden. These relationships are shown in Figure 1. It is possible, therefore, that the sediment suspended in the water of these two rivers reflects this marked difference in bedrock lithology. The most direct means of testing this hypothesis is to use x-ray diffraction methods to determine the mineralogy of the suspended sediments. With this objective in mind twelve water samples were taken, six from each river. The sampling area spanned about 15 miles along the course of the Olentangy River and about 20 miles along that of the Scioto River. The sampling locations are shown on Figure 2. The objectives of this experiment were threefold: (1) To see how accurately the mineralogy of the suspended river sediments reflected that of the respective bedrock types; (2) to determine what, if any, minerals were present which could not be attributed to the local bedrock;
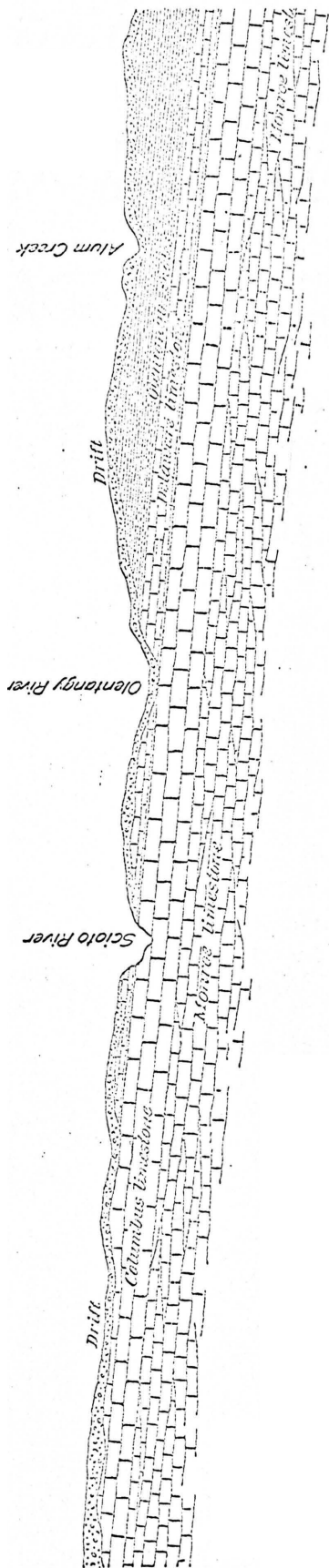
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Fig. 1

A section of the bed rock along a line drawn through Columbus from west to east. Horizontal scale, one inch equals two miles; vertical scale, one inch equals 630 feet.

Adapted from Geological Survey of Ohio, Fourth Series, Bulletin 14, 1911. Plate VII

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(3) to see if any other crystalline contaminants were present and to determine their origins.
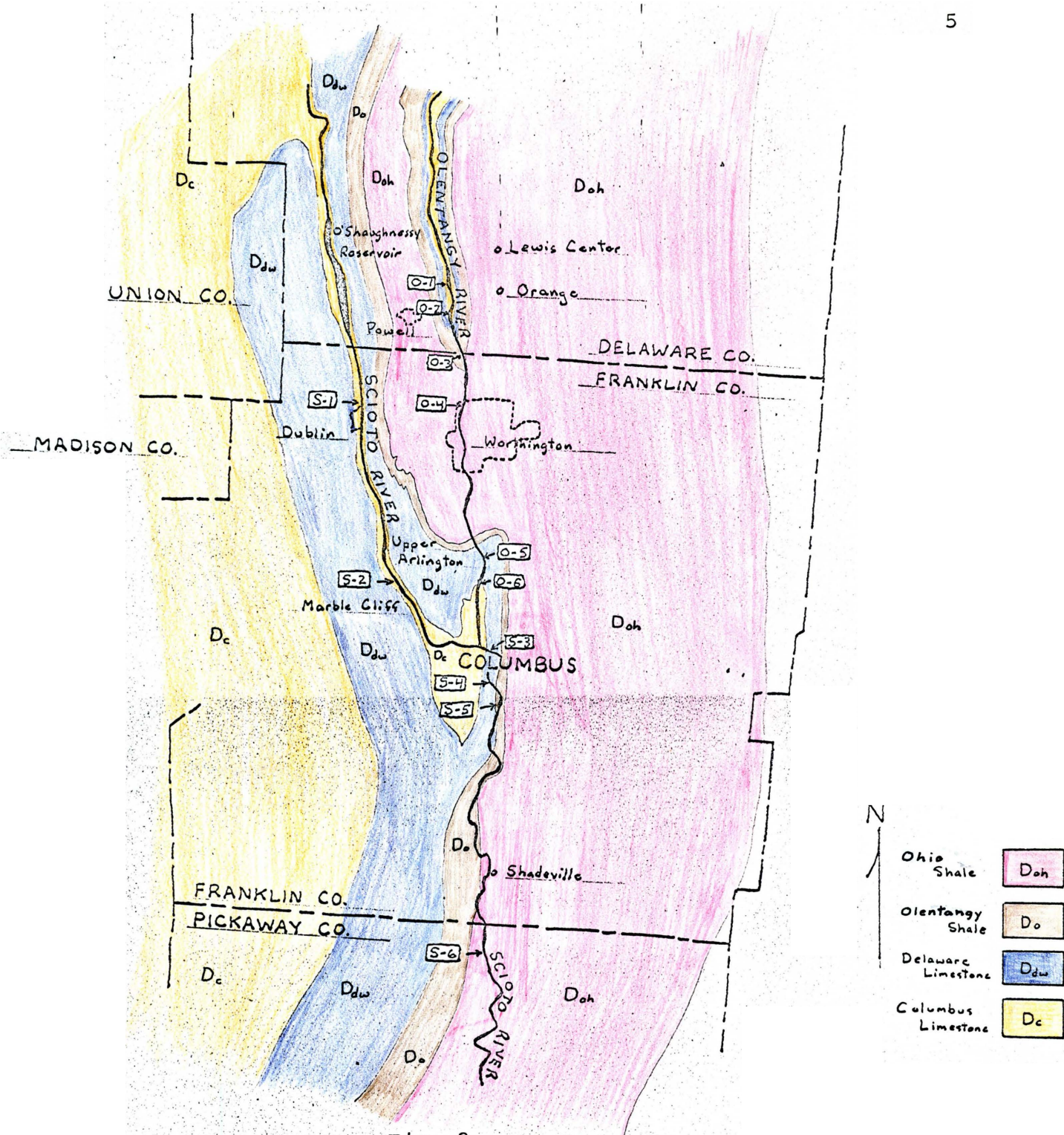
D_{dw}

D_o

D_c

D_{oh}

D_{oh}

O'Shaughnessy Reservoir

OLENTANGY RIVER

o Lewis Center

o Orange

UNION CO.

D_{dw}

O-1

O-2

Powell

DELAWARE CO.

FRANKLIN CO.

O-3

S-1

O-4

MADISON CO.

Dublin

SCIOTO RIVER

Worthington

Upper Arlington

O-5

S-2

D_{dw}

O-6

Marble Cliff

D_c

D_{dw}

S-3

D_{oh}

D_c COLUMBUS

S-4

S-5

D_o

o Shadeville

FRANKLIN CO.

PICKAWAY CO.

D_c

D_{dw}

S-6

SCIOTO RIVER

D_{oh}

D_o

Fig. 2

N

Ohio Shale	D_{oh}
Olentangy Shale	D_o
Delaware Limestone	D_{dw}
Columbus Limestone	D_c

SCALE IN MILES

0   5   10
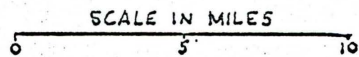
ANALYTICAL PROCEDURE

Twelve water samples were taken on September 6, 1971, six from the Scioto River and six from the Olentangy River. At each collecting locality the sample was taken from the riverbank with a plastic bucket, then poured into a clean 500 ml. polyethylene bottle. The bucket was rinsed before each sampling and the bottles were labeled with their respective sample number, location, and date and time collected. This information is given in Table 1.

All twelve samples were then filtered twice. "Coarse filtration" was through a Whatman #1 filter paper, removing most of the organic material and the coarse sediment fraction. "Final filtration" was through a millipore filter unit, which filtered out all remaining suspended sediment greater than 0.45 microns in diameter.

The millipore filter papers from the twelve samples were dried in air and then glued to glass slides using rubber cement. Before x-raying the sample mounts, a blank mount was prepared by gluing a blank millipore filter paper to a glass slide. This blank mount was x-rayed first as a control. The diffraction analysis was carried out for 2θ values from 5° to 60° using a General Electric Model XRD-6 x-ray diffractometer and Cu K-alpha, Nickel-filtered x-rays.

TABLE 1

Sampling Date - September 6, 1971

Sample	Location	Type of Bedrock	Mineralogy
O-1 collected at 10:30 A.M.	Olentangy River near Orange Run Dr., beneath the bridge	Columbus Limestone	Talc Illite Chlorite + Kaolinite Quartz
O-2 collected at 10:20 A.M.	Olentangy River just N of Rt. 750	Delaware Limestone	Talc Illite Chlorite + Kaolinite Quartz Gypsum Montmorillonite
O-3 collected at 10:12 A.M.	Olentangy River just S of Delaware County line	Olentangy Shale	Talc Chlorite + Kaolinite Quartz Calcite
O-4 collected at 9:55 A.M.	Olentangy River N end of Worthington	Ohio Shale	Talc Illite Chlorite + Kaolinite Quartz Calcite
O-5 collected at 9:30 A.M.	Olentangy River just S of bridge at Lane Ave., on Ohio State Univ. grounds	Olentangy Shale	Talc Quartz Dolomite
O-6 collected at 1:58 P.M.	Olentangy River beneath King Ave. bridge	Delaware Limestone	Talc Dolomite Orthoclase Gypsum (tr.)*

TABLE 1 (continued)

Sample	Location	Type of Bedrock	Mineralogy
S-1 collected at 11:02 A.M.	Scioto River northern out-skirts of Dublin	Columbus Limestone	Talc Montmorillonite Chlorite + Kaolinite Quartz Wolframite (tr.)
S-2 collected at 11:30 A.M.	Scioto River beneath Trabue Rd. bridge	Columbus & Delaware Limestone	Talc Illite Chlorite + Kaolinite Fayalite
S-3 collected at 11:47 A.M.	Scioto River just off Civic Center Dr., S of intersection of Scioto and Olentangy Rivers	Delaware Limestone	Talc Illite Montmorillonite Chlorite + Kaolinite Chlorite - Montmorillon-ite Quartz Calcite Albite Labradorite Siderite
S-4 collected at 12:25 P.M.	Scioto River 1 mile N of Greenlawn Dam	Delaware Limestone	Talc Illite Quartz Calcite Orthoclase Fayalite Siderite
S-5 collected at 12:12 P.M.	Scioto River just S of Greenlawn Dam	Olentangy Shale	Talc Illite Chlorite + Kaolinite Quartz Calcite Dolomite Hydrobiotite

TABLE 1 (continued)

Sample	Location	Type of Bedrock	Mineralogy
S-6 collected at 1:15 P.M.	Scioto River beneath bridge on Rt. 762, 4 miles S. of Shadeville	Ohio Shale	Talc Illite Chlorite + Kaolinite Chlorite - Montmorillon- ite Quartz Calcite

*
Tr = trace

The strip charts from each of the twelve samples were analyzed and the mineralogy of each sample was determined from the 2θ peaks present on that chart. The identifications were made using a compilation of x-ray spectra of common minerals by Chao (1969). These are shown in Table 2, a-p.

The approximate relative abundances of the minerals present in each sample were calculated from the 2θ peak heights (relative intensities). In order to standardize this procedure a representative peak was chosen for each mineral and used in the calculations for all the samples. The peaks were chosen on the basis of being either the strongest peak for that mineral, or the most frequently appearing. The heights of the selected peaks were measured and the approximate relative abundances of each mineral were calculated using the following relationship:

$$\% \text{ Talc} = \frac{I_{talc}}{I_{talc} + I_{illite} + I_{qtz...}} \times 100$$

where I = Intensity as measured on the chart in arbitrary units. In the identification and subsequent calculations chlorite and kaolinite were grouped together as there was not sufficient resolution of the 2θ peaks to distinguish between them.

Table 2

2θ values present from samples

2θ ASTM	Intensity ASTM	O-1	O-2	O-3	O-4	O-5	O-6	S-1	S-2	S-3	S-4	S-5	S-6
a) TALC													
9.47	100	9.48	9.50	9.51	9.42	9.44	9.47	9.48	9.46	9.49	9.48	9.49	9.53
28.65	100	28.65	28.52	28.74	28.63	28.65	28.67	28.67	28.68	28.75	28.67	28.71	28.57
19.04	90	–	–	18.94	–	–	–	19.10	18.94	–	19.11	–	19.18
36.28	65	–	–	–	–	–	–	–	–	–	–	–	–
48.69	40	48.70	–	–	–	–	–	–	–	–	–	–	–
b) ILLITE													
8.84	100	8.80	8.81	8.81	8.84	–	–	–	8.81	8.86	8.83	8.86	8.87
19.82	90	19.65	19.75	–	–	–	–	–	–	–	–	–	–
26.77	90	26.77	–	–	26.68	–	–	–	–	26.69	26.70	–	26.66
34.36	60	–	–	–	–	–	–	–	–	–	–	–	–
c) QUARTZ													
26.66	100	26.70	26.63	26.73	26.68	26.51	–	26.63	–	26.69	26.70	26.68	26.66
20.85	35	20.87	20.75	–	20.75	–	–	–	–	20.80	20.88	20.75	20.85
50.21	17	–	–	–	–	–	–	–	–	–	–	–	–
d) CALCITE													
29.43	100	–	–	29.35	29.48	–	–	–	–	29.52	29.44	29.43	29.25
39.43	18	–	–	–	–	–	–	–	–	39.48	–	–	–
36.00	14	–	–	–	–	–	–	–	–	–	35.94	–	–
e) DOLOMITE													
30.99	100	–	–	–	–	30.99	30.86	–	–	–	–	31.00	–
41.18	30	–	–	–	–	–	–	–	–	–	–	–	–
51.14	30	–	–	–	–	–	–	–	–	–	–	–	–

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Squares to the Inch

TABLE 2 (cont.)

2θ values present from samples

2θ ASTM	Intensity ASTM	O-1	O-2	O-3	O-4	O-5	O-6	S-1	S-2	S-3	S-4	S-5	S-6
f) CHLORITE and KAOLINITE													
12.31 – 12.83	100	12.30	12.31	12.36	12.34	-	-	12.63	12.38	12.28	-	12.45	12.38
24.80 – 25.52	100	24.85	-	25.08	24.72	-	-	-	-	25.31	-	-	-
19.68 – 20.50	90	19.68	19.75	20.32	-	-	20.57	20.49	-	-	-	-	-
g) MONTMORILLONITE													
5.89	100	-	-	-	-	-	-	-	-	-	-	-	-
19.73	80	-	19.75	-	-	-	-	-	-	-	-	-	-
17.70	60	-	-	-	-	-	-	17.78	-	17.75	-	-	-
29.58	60	-	29.30(?)	-	-	-	-	-	-	29.52	-	-	-
34.77	40	-	35.13(?)	-	-	-	-	34.85	-	-	-	-	-
h) CHLORITE – MONTMORILLONITE													
19.60	100	-	-	-	-	-	-	-	-	19.51	-	-	19.54
5.89	90	-	-	-	-	-	-	-	-	-	-	-	-
17.85	75	-	-	-	-	-	-	-	-	17.75	-	-	-
i) GYPSUM													
20.80	51	-	20.75	-	-	-	20.86	-	-	-	-	-	-
11.71	100	-	11.62	-	-	-	-	-	-	-	-	-	-
29.19	57	-	29.30	-	-	-	-	-	-	-	-	-	-
23.47	21	-	-	-	-	-	23.39	-	-	-	-	-	-
j) ORTHOCLASE													
28.06	100	-	-	-	-	-	-	-	-	-	28.11	-	-
22.11	90	-	-	-	-	-	22.15	-	-	-	22.28	-	-
23.41	80	-	-	-	-	-	23.39	-	-	-	-	-	-
26.77	70	-	-	-	-	-	-	-	-	-	26.70	-	-

TABLE 2 (cont.)

2θ values present from samples

k) ALBITE

2θ ASTM	Intensity ASTM	O-1	O-2	O-3	O-4	O-5	O-6	S-1	S-2	S-3	S-4	S-5	S-6
27.92	100	—	—	—	—	—	—	—	—	27.93	—	—	—
23.54	25	—	—	—	—	—	—	—	—	23.53	—	—	—
13.86	20	—	—	—	—	—	—	—	—	13.94	—	—	—

l) LABRADORITE

2θ ASTM	Intensity ASTM	O-1	O-2	O-3	O-4	O-5	O-6	S-1	S-2	S-3	S-4	S-5	S-6
27.88	100	—	—	—	—	—	—	—	—	27.93	—	—	—
21.84	40	—	—	—	—	—	—	—	—	21.95	—	—	—
35.48	27	—	—	—	—	—	—	—	—	—	—	—	—

m) FAYALITE

2θ ASTM	Intensity ASTM	O-1	O-2	O-3	O-4	O-5	O-6	S-1	S-2	S-3	S-4	S-5	S-6
31.60	100	—	—	—	—	—	—	—	31.62	—	31.50	—	—
35.91	70	—	—	—	—	—	—	—	36.15	—	35.94	—	—
34.97	50	—	—	—	—	—	—	—	34.86	—	35.11	—	—

n) WOLFRAMITE

2θ ASTM	Intensity ASTM	O-1	O-2	O-3	O-4	O-5	O-6	S-1	S-2	S-3	S-4	S-5	S-6
30.27	100	—	—	—	—	—	—	30.27	—	—	—	—	—
36.18	60	—	—	—	—	—	—	—	—	—	—	—	—
24.40	50	—	—	—	—	—	—	24.52	—	—	—	—	—

o) SIDERITE

2θ ASTM	Intensity ASTM	O-1	O-2	O-3	O-4	O-5	O-6	S-1	S-2	S-3	S-4	S-5	S-6
32.08	100	—	—	—	—	—	—	—	—	32.05	32.03	—	—
52.79	80	—	—	—	—	—	—	—	—	—	—	—	—
24.80	60	—	—	—	—	—	—	—	—	—	—	—	—

p) HYDROBIOTITE

2θ ASTM	Intensity ASTM	O-1	O-2	O-3	O-4	O-5	O-6	S-1	S-2	S-3	S-4	S-5	S-6
7.75	100	—	—	—	—	—	—	7.75	—	—	—	—	—
26.13	80	—	—	—	—	—	—	—	—	—	—	26.11	—
34.22	80	—	—	—	—	—	—	—	—	—	—	34.15	—
37.15	40	—	—	—	—	—	—	—	—	—	—	37.29	—

PRESENTATION OF RESULTS AND INTERPRETATIONS

The minerals identified from the samples and their
relative abundance in each sample are shown in Table 3.
Table 2, a-p, shows how the positive identifications were
made. These charts show standard ASTM 2θ values as com-
piled by Chao (1969) compared with the 2θ values measured
from the strip charts. The graphs in Figure 3 show the
percentages of the five most common minerals plotted
against the distance from the northernmost sample collect-
ing locality (farthest upstream) for each sample. The
locations where samples were collected appear on the
geologic map in Figure 2.

Some interesting conclusions can be drawn from these
data. First of all it appears that the mineralogy of the
suspended sediment does indeed reflect the bedrock over
which each river flows. Calcite is present in four of six
samples from the Scioto River, but only two of six samples
from the Olentangy River. In addition, the relative
abundances of calcite in the samples from the Scioto River
are substantially higher. The average relative abundance
of calcite in the Scioto samples is 9.17% compared to
only 2.66% for those taken from the Olentangy River.

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TABLE 3

ABUNDANCE OF MINERALS PRESENT
(in per cents)

	0-1	0-2	0-3	0-4	0-5	0-6	S-1	S-2	S-3	S-4	S-5	S-6
Talc	19.85	33.34	49.49	52.19	76.92	62.44	66.78	58.18	36.63	41.61	28.65	29.69
Illite	34.34	15.22	—	10.64	—	—	—	15.72	10.48	6.87	3.78	13.91
Montmorillonite	—	trace	—	—	—	—	10.59	—	9.84	—	—	—
Chlorite and Kaolinite	20.39	13.44	15.81	10.90	—	—	11.30	17.09	7.06	—	4.39	12.39
Chlorite - Montmorillonite	—	—	—	—	—	—	11.30	—	9.23	—	—	10.62
Quartz	25.42	20.46	21.92	22.88	9.34	—	—	—	13.81	19.31	6.36	23.08
Calcite	—	—	12.78	3.19	—	—	—	—	6.76	15.41	22.54	10.31
Dolomite	—	—	—	—	13.74	14.52	—	—	—	27.52	—	—
Orthoclase	—	—	—	—	—	23.01	—	—	—	10.17	—	—
Albite	—	—	—	—	—	—	—	—	6.15	—	—	—
Labradorite	—	—	—	—	—	—	—	—	trace	—	—	—

TABLE 3 (continued)

	O-1	O-2	O-3	O-4	O-5	O-6	S-1	S-2	S-3	S-4	S-5	S-6
Gypsum	-	17.51	-	-	-	trace	-	-	-	-	-	-
Fayalite	-	-	-	-	-	-	-	9.01	-	6.62	-	-
Wolframite	-	-	-	-	-	-	trace	-	-	-	-	-
Siderite	-	-	-	-	-	-	-	-	trace	trace	-	-
Hydrobiotite	-	-	-	-	-	-	-	-	-	-	6.76	-

Fig. 3 (a)

OLENTANGY RIVER SAMPLES

% TALC •

% ILLITE ○

% QUARTZ △

% CALCITE ▫

% CHLORITE-

KAOLINITE ▲

DISTANCE IN MILES
(from farthest upstream sample collecting location)

Fig. 3 (b)

SCIOTO RIVER SAMPLES

%'TALC •

% ILLITE ○

% QUARTZ △

% CALCITE ▫

% CHLORITE-

KAOLINITE ▲

DISTANCE IN MILES
(from farthest upstream sample collecting location)
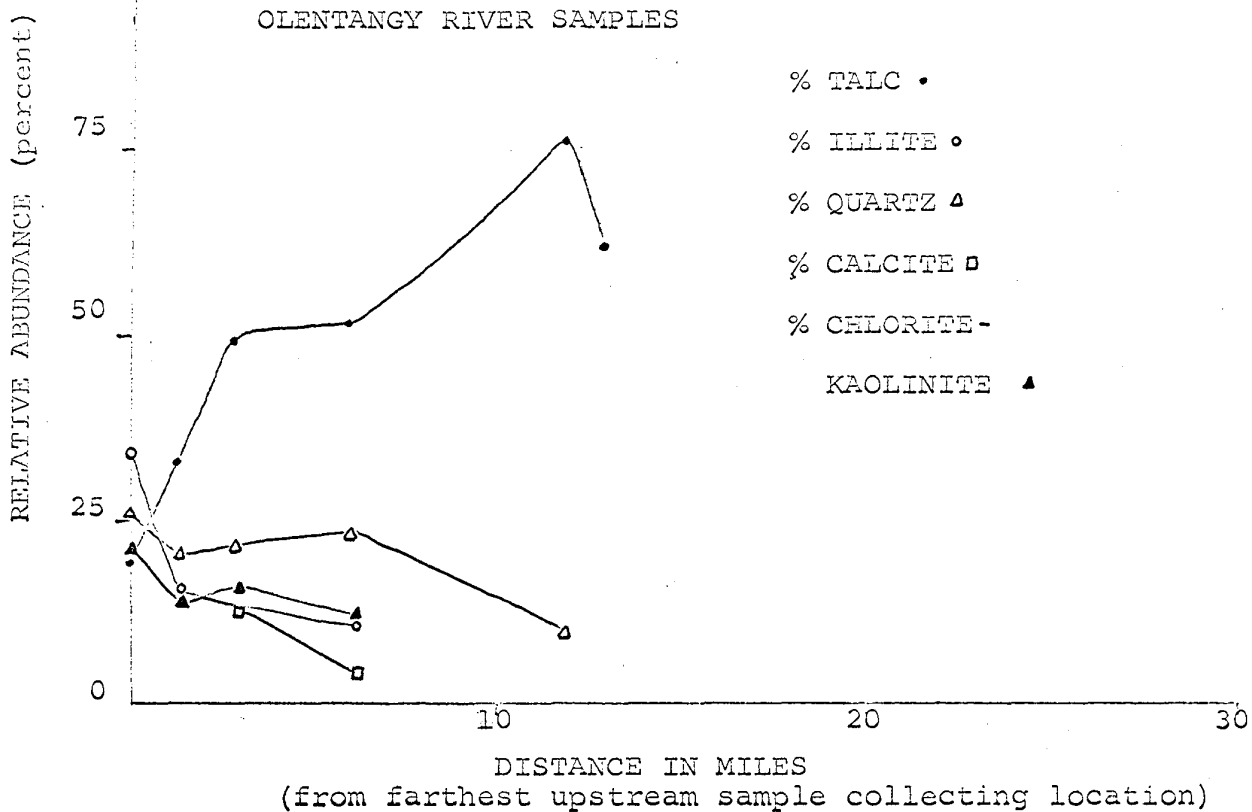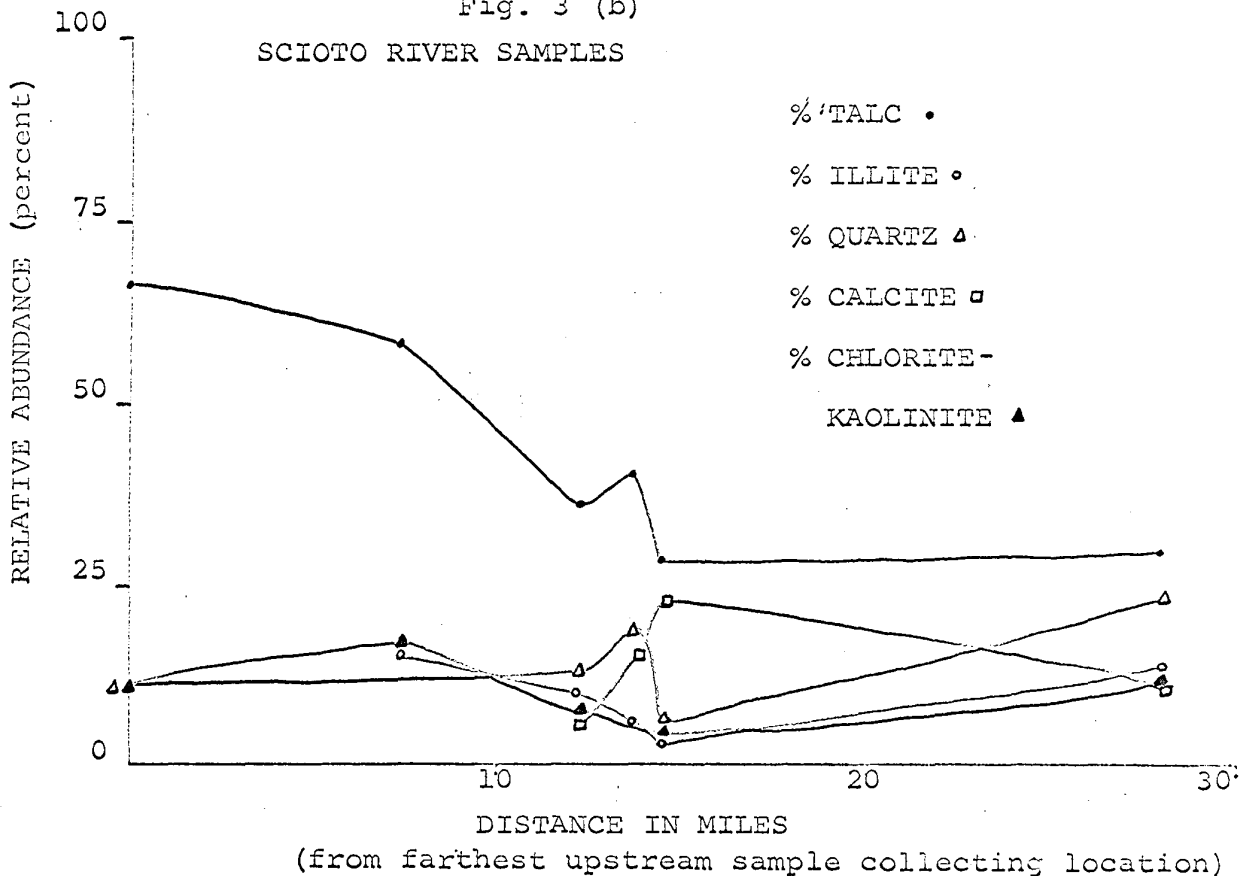
The higher calcite content of the suspended sediment in water from the Scioto River is in accordance with the fact that the Scioto River flows over bedrock that is predominantly composed of carbonate rocks (see Figure 1). The influence of bedrock lithology on the mineral composition of the suspended sediment in the two rivers is reinforced by the data for the clay minerals. The only clay minerals that can be positively attributed to the weathering of bedrock are illite and the chlorite-kaolinite group. (Montmorillonite is an alteration product of volcanic ash and chlorite-montmorillonite is a product of hydrothermal alteration.) The relative abundance of clay minerals is higher in the samples from the Olentangy River than for the samples from the Scioto River. The average percentages (for illite and the chlorite-kaolinite group taken together) show about 20.12% clay per sample from the Olentangy as compared with only 17.17% clay per sample from the Scioto. This appears to be significant because the Olentangy River flows over bedrock which consists predominantly of the Olentangy and Ohio Shales of Devonian age. It is interesting to note that in the Scioto River the abundances of illite and the chlorite-kaolinite group increase south of Columbus, below the confluence of the two rivers, where the Scioto River flows over the Olentangy and Ohio Shales.

Quartz seems to be almost universally present, occurring in ten of the twelve samples. It, too, seems to appear in substantially higher percentages in the samples taken from the Olentangy River. One would expect quartz to be more abundant in shale than in a limestone; however, the Delaware limestone does contain abundant chert nodules.

Other minerals are present in the sediments which could not possibly have been derived from the bedrock underlying the two rivers. Fayalite (?), hydrobiotite and the feldspars can probably be attributed to the glacial drift which overlies this area (see Figure 1), as can the clay minerals, montmorillonite and chlorite-montmoril-lonite, whose origins have previously been discussed. Surprisingly, gypsum was found in two of the samples (O-2 and O-6). Perhaps this minerals could be traced to the abundant evaporite deposits of northwest Ohio.

The most startling and significant result of this experiment was the discovery of talc as the most abundant constituent in eleven of the twelve samples. The sample x-ray diffractograms in Figure 4 show the presence of talc positively. Talc is metamorphic in origin and is relatively rare in comparison to other silicates like quartz and the feldspars. There are no deposits of talc in Ohio, and it is inconceivable that such a high concentration of this mineral could have been brought down

Fig. 4

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Fig. 4

Blank Slide and Filter Paper

S-1

O-4

P-5
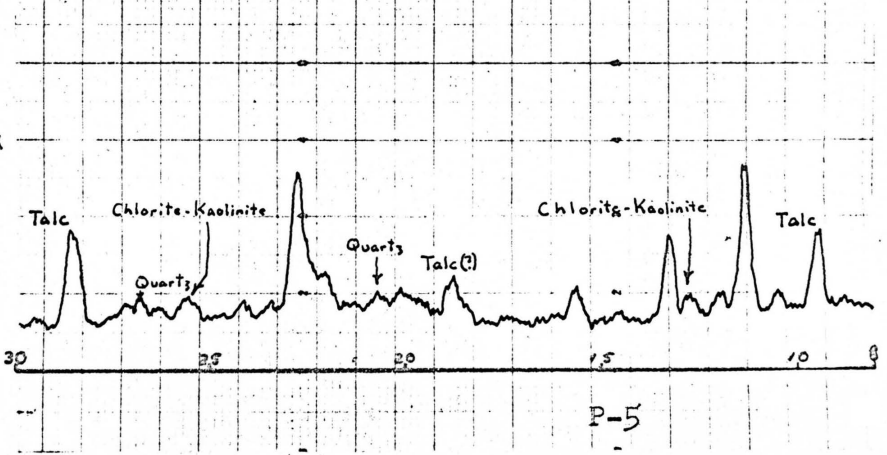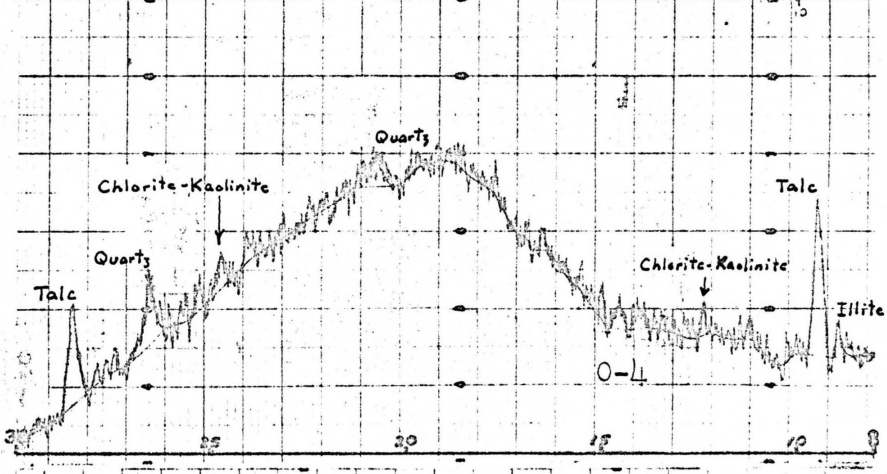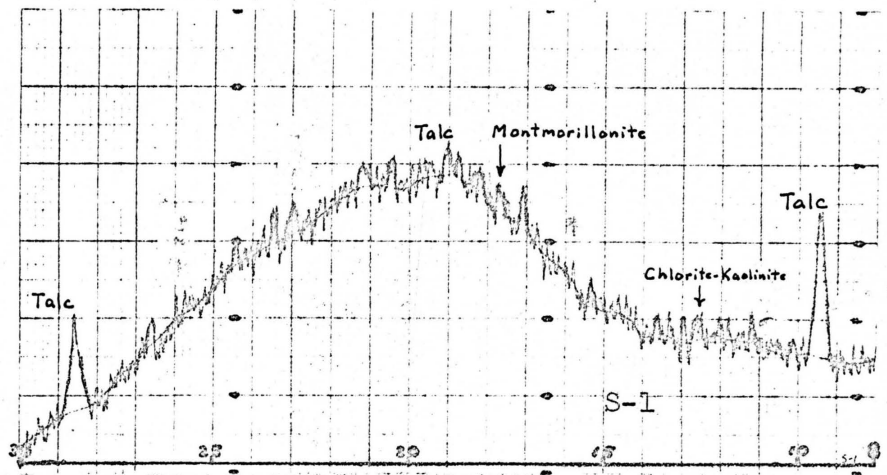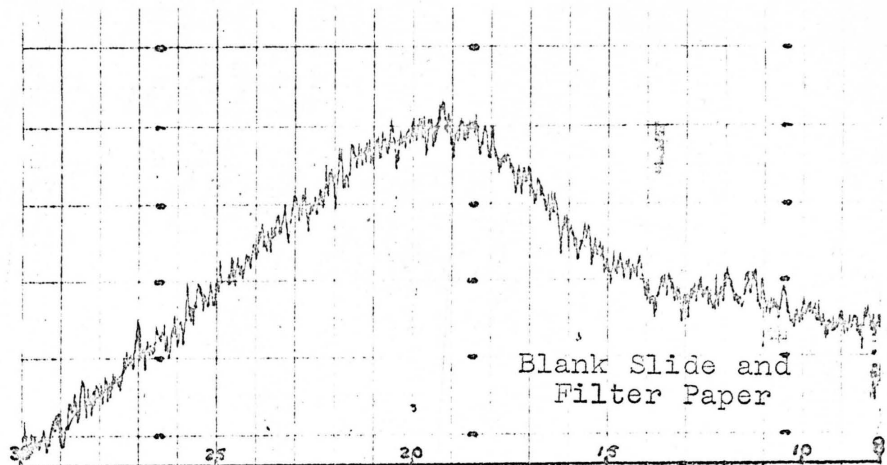
from the Canadian Shield by the Pleistocene glaciation. Since the occurrence of talc in the suspended sediment cannot plausibly be attributed to natural phenomena, it may have been introduced artifically by man.

Talc is known to be used as a carrier-extended for pesticides. It seems logical that talc could have been introduced into both rivers by either (1) air transport or (2) heavy rainfall immediately after pesticide spraying, washing the powders into the rivers and streams. Supporting the first mode of introduction is an article by Risebrough et al. (1968). They stated:

"Various lines of evidence indicate air transport: i) the codistillation of chlorinated hydrocarbons with water, and ii) their detection in air and rainwater and in atmospheric dust originating in Texas and subsequently deposited in Ohio. . . .

Complementing such work is the observation that the mineral talc that is used as a carrier and diluent for pesticides occurs in the solid mineral phases of rains, glaciers, and rivers and in dusts recovered from the atmosphere in concentrations much higher than expected from natural occurrences; its existence in airborne particulate matter over the sea suggests a link with the global dispersion of pesticides."

In order to test the hypothesis that the talc in the
Olentangy and Scioto River sediments can be attributed to
the use of pesticide powders in the drainage basin, six
pesticide samples were obtained and x-rayed. The same
procedure was used as has been previously described except
that the diffraction pattern was made for 2θ values of
from 5° to 40°. The names of the six pesticide powders
and other pertinent information appears in Table 4. The
results of the x-ray diffraction work is given in Table 5,
a-h.

Talc can be positively identified in two of the six
samples (Phaltan and Baygon), and is a major constituent
of those products. Since these pesticides were obtained
in the Columbus area, it is very possible that such
pesticides are the source of the talc found in the rivers.

The graphs in Figure 3 show two interesting relation-
ships. From the point where the first sample was taken
in the Olentangy River south toward Columbus there appears
to be a general increase in the abundance of talc in the
sediments. Sample O-1 shows 19.85% talc and this figure
increases to 76.92% talc in O-5, falling slightly to
62.44% in O-6. The location of Whetstone Park 2½ miles
upstream from collecting site O-5 and of Ohio State Uni-
versity from whose grounds O-5 was taken suggest a
possible explanation for the marked increase in the
abundance of talc in this section of the Olentangy River.

TABLE 4

Pesticides

Sample Number	Commercial Name	Ingredients	Manufacturer
P-1	6% Chlordane	Technical Chlordane 6% (3.6 otachlora - 4, 7 - methanotetrahydroindane + 2.4% related compounds on a weight basis) Inert ingredients 94%	Parrott Chemical Company
P-2	PEST-B-GON 50% DDT	Dichlora Diphenyl Trichloroethane 50% Inert ingredients 50%	Chevron Chemical Co. Ortho Division San Francisco, California
P-3	PHALTAN (fungicide)	Folpet 75% (trichloromethylthio phthalimide) Inert ingredients 25%	Chevron Chemical Co. Ortho Division San Francisco, California
P-4	Sergeant's Flea and Tick Powder	Carbaryl 5% C 1 - Naphthyl N-Methylcarbamate) Captan 3% (N-trichloromethylthio-4-cyclohevene - 1,2 dicarboximide) Inert ingredients 94.7%	Polk Miller Products Corp. Richmond, Virginia
P-5	BAYGON	O-Isopropoxyphenyl methylcarbamate 50% Inert ingredients 50%	Chemagro Corp. Research Dept. Kansas City, Missouri
P-6	DIAZINON 50W	O, O-diethyl O-(2-isopropyl-4-methy-6-pyrimidinyl) phosphorathioate 50% Inert ingredients 50%	Geigy Agricultural Chemicals, Division of Geigy Chemical Corp., Ardsley, New York

TABLE 5

Minerals Identified from Pesticide and Fungicide Powders

a) TALC

2θ values present from samples

2θ ASTM	Intensity ASTM	P-1	P-2	P-3	P-4	P-5	P-6	P-7
9.47	100	–	–	9.47	9.53	9.41	–	9.52
28.65	100	–	–	28.39(?)	–	28.55	–	28.65
19.04	90	–	–	–	–	18.86(?)	–	18.95
36.28	65	–	–	–	–	–	–	–
48.69	40	–	–	–	–	–	–	–
19.51	30	–	–	19.46	–	–	–	–
34.56	30	–	–	–	–	–	–	–

b) PYROPHYLLITE

2θ values present from samples

2θ ASTM	Intensity ASTM	P-1	P-2	P-3	P-4	P-5	P-6	P-7
29.38	100	–	–	29.37	–	29.41	29.42	–
29.09	100	–	–	–	29.09	–	–	–
28.99	100	29.02	–	–	–	–	–	–
20.04	86	–	–	–	–	20.05	–	–
37.15	72	–	–	37.17	–	–	–	–
9.60	60	9.61	–	–	–	–	–	–
35.05	57	–	–	–	–	–	–	–
19.38	50	19.25	–	–	–	–	–	–
19.42	50	–	–	19.46	19.36	–	–	–
9.31	46	–	–	–	–	–	–	–
9.68	40	–	–	–	–	–	–	–
37.47	40	–	–	–	–	–	–	–
21.41	34	–	–	–	–	–	–	–
26.69	30	–	–	–	–	–	–	–
20.18	20	–	–	–	–	–	–	–
21.31	15	–	–	–	–	–	–	–
36.84	15	–	–	36.82	–	–	–	–
35.19	10	–	–	–	–	–	–	–

TABLE 5 (continued)

c) QUARTZ

2θ values present from samples

2θ ASTM	Intensity ASTM	P-1	P-2	P-3	P-4	P-5	P-6	P-7
26.66	100	26.58	26.55	26.78	26.65	26.72	26.70	-
20.85	35	20.82	20.86	20.84	20.90	-	-	-

d) CHLORITE and KAOLINITE

2θ values present from samples

2θ ASTM	Intensity ASTM	P-1	P-2	P-3	P-4	P-5	P-6	P-7
12.31-12.83	100	12.31	-	12.32	-	12.69	-	-
24.80-25.52	100	24.80	-	24.91	24.79	25.53	-	-
19.68-20.50	90	19.85	-	20.50	-	-	-	-

f) ANDALUSITE

2θ values present from samples

2θ ASTM	Intensity ASTM	P-1	P-2	P-3	P-4	P-5	P-6	P-7
16.00	100	-	-	16.00	-	-	-	-
19.60	90	-	-	-	-	-	-	-
32.32	90	-	-	32.28	-	-	-	-

TABLE 5 (continued)

2θ ASTM	Intensity ASTM	P-1	P-2	P-3	P-4	P-5	P-6	P-7
				g) SILLIMANITE				
			2θ values present from samples					
26.53	100	--	--	(?)26.78	--	--	--	--
26.13	90	--	--	26.07	--	--	--	--
35.48	90	--	--	35.30	--	--	--	--
31.05	70	--	--	31.05	--	--	--	--
				h) MONTMORILLONITE				
			2θ values present from samples					
19.73	100	--	19.80	--	--	--	--	--
29.09	100	--	29.26	--	--	--	--	--
34.36	100	--	34.39	--	--	--	--	--
35.14	100	--	35.09	--	--	--	--	--

The Park and the University are charged with protecting
their vegetation from insect harm, and thus are probably
major users of pesticides. Several unsuccessful attempts
were made to obtain pesticide powder samples from these
sources.

The Scioto River, however, shows a general decrease
in talc downstream from collecting site S-1, from 66.78%
in S-1 to only 29.69% in S-6. This can probably be
attributed to the fact that north of Columbus the Scioto
River drains an area which is predominantly agricultural
and would thus have a great need for pesticides. There
is a large fruit farm on Sawmill Road in this area. Also,
north of collecting site S-1 lies O'Shaughnessy Reservoir,
a large recreation center for the Columbus area. It is
possible, but not yet confirmed, that pesticides are being
used both to maintain the purity of the water by killing
algae, and to kill mosquitoes. As Columbus is approached
going downstream along the Scioto, the adjacent area
becomes more residential and industrial. This may account
for declining talc percentages. The graph in Figure 3b
also shows a slight increase in the abundance of talc
between samples S-5 and S-6, rising from 28.65% in
S-5 to 29.69% in S-6. This can probably be attributed to
the passing of the Scioto River from an industrial area to
a more agricultural one.

It would seem that the presence of talc in the Olentangy and Scioto Rivers is due to the use of pesticides. Also indicative of their presence would be pyrophyllite, an isomorph of talc. Pyrophyllite was positively identified in four of the six pesticide samples x-rayed. Pyrophyllite did not, however, appear in any of the sediments from either the Scioto or Olentangy Rivers.

The possibility arises that talc may be used as a quantitative tracer for pesticides. Risebrough et al. (1968) pointed out, however, that talc as a carrier-extender for pesticides is gradually being replaced by water or light distillates of petroleum. When present, though, talc would seem to provide an excellent indication of environmental contamination from pesticides.

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