PRELIMINARY STUDY OF THE SEDIMENTATION OF LAKE ST. CLAIR FROM MINOR RIVER AND STREAM TRIBUTARIES

By

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ABSTRACT

Sediment samples collected from the minor tributary streams and rivers of Lake St. Clair were analyzed to determine if there were any distinct mineral assemblages within the < 64 micrometer size fraction. These assemblages could then identify lake sediment provenances.

Mineral assemblages were identified for all the streams and rivers by x-ray dffraction analysis, and were found to be uniform in composition. It is suggested that the sources for the suspended and bottom sediments of the streams and rivers have similar compositions, such as that of a uniform till plain. The distribution patterns of the fluvially transported sediments in the lake can not be determined solely on the basis of the composition of the < 64 micrometer size fraction.

ACKNOWLEDGEMENTS

I would like to express thanks to my father who helped complete the field work on a very cold Thanksgiving weekend. Without his help the work would not have been completed. I am also thankful to Dr. G.D. McKenzie for suggesting the project.

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INTRODUCTION

Lake St. Clair is a shallow fresh water lake which is a part of the Great Lake water system. The lake borders southeastern Michigan and southwestern Ontario. It's shape is ellipsoidal with the long axis (25 miles in length) trending northeast. The short axis is approximately 20 miles long. Excluding the shipping channels, which are 26 feet deep, the maximum depth in the lake is 19 feet. The lake's major tributary is the St. Clair river (see fig. 1). The St. Clair river empties into the lake and forms a prograding delta of the Mississippian birds-foot type (Pezzetta 1968). Most of the lake's sediment enters the lake basin from this delta. Drainage for the lake is the Detroit River located in the southwestern corner of the lake. The Detroit river then empties into the western basin of Lake Erie (Giampaolo, 1984).

Previous sedimentological studies of Lake St. Clair have concentrated on the prograding delta. The delta was first described by Cole 1935. Further studies have been conducted by Wightman, 1961 and Pezzetta, 1968. There have not been any previous studies of the sediment influx into the basin from the minor river and stream tributaries. A mineralogical study of the sediment from these rivers and streams could be used in the sediment distribution patterns of the lake. The study could also be used in identifying the sources of the sediments (provenance) that are being transported in the rivers and streams. This study would aid geologists in understanding sediment dispersion in shallow lakes. It would also assist current studies by the Department of Geology and Mineralogy at The Ohio State University on sediment dispersion in the western basin of Lake Erie.

Samples were collected from the Clinton River, Clinton River cut off channel, and the Milk River on the Michigan side of the lake. On the

Figure 1. Locality of Lake St. Clair

Canadian side Pike Creek, Puce River, Belle River, Ruscom River, Thames River, Jeannettes Creek and Big Creek will also be sampled (see plate A and fig. 2). The sediment was processed and then analyzed with x-ray diffraction to determine the mineral composition of each sample. Since the study is only a preliminary study, only the < 64 micrometer size fraction was analyzed. The silt and clay fraction (< 64 micrometer fraction) is a good representative fraction to analyze because it is the most probable size fraction to be transported into the lake. Only during the spring high water outflows would the > 64 micrometer size fractions be transported into the lake from the rivers.

SAMPLING METHODS

Samples were collected from the minor streams and rivers that drain into Lake St. Clair (see table 1 and 2). At each stream, samples were taken to represent the stream profile as best as possible. The samples were taken from bridges as close to the lake as possible to get a representative sample of the actual sediment that is being contributed to the lake from the stream or river. The number of samples depended on the width of the river or stream and the bridge buttress structure. River names are represented by the first two letters in the sample code. The third letter is either a W or B for water or bottom sample respectively. The fourth letter represents the location of the sample in the sampling profile (see fig. 2). The bottom samples were collected with a LaMotte Chemical bottom sampling dredge. The samples were stored in plastic zip lock bags to prevent them from drying out during storage. One gallon of water was collected 0.5 meters above each of the bottom sample locations with a Kemler water sampler, and was stored in clean one-gallon jugs.

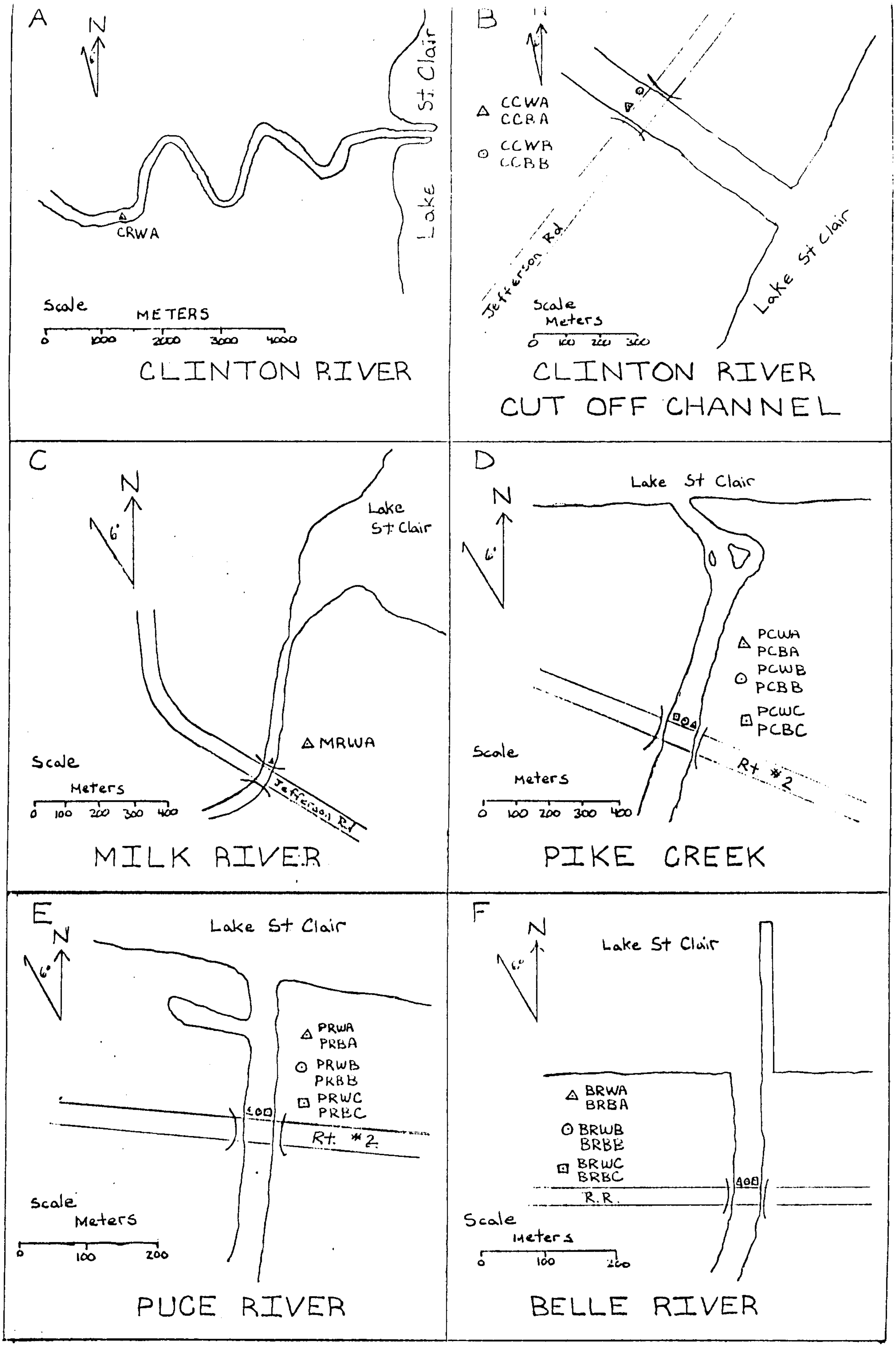

Figure 2. Sample location, 2A Clinton R., 2B Clinton R. Cut Off Channel, 2C Milk R., 2D Pike Cr., 2E Puce R,. 2F Belle R. Note: river width is exaggerated to show detail.

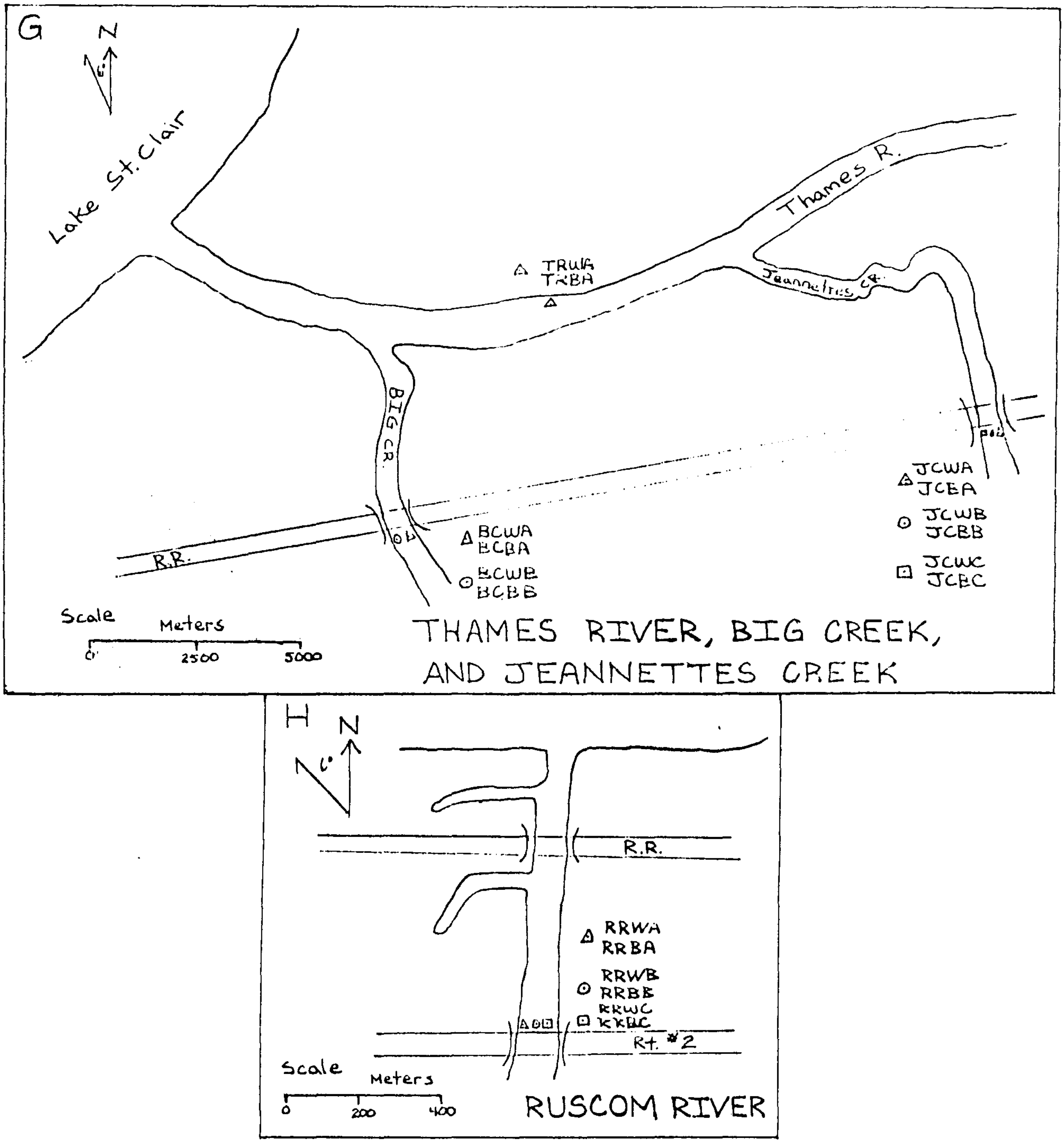

Figure 2. Sample location, 2G Thames R., Big Cr., Jeannettes Cr., 2H Ruscom R. Note: river width is exaggerated to show detail.

TABLE 1 SAMPLE LOCATION AND DATA FROM CANANDIAN RIVERS

SAMPLE		WIDTH	DEPTH (Meters)	LOCATION
PIKE CREEK				
	PCWA	12	1.0	E. side of Route # 2 bridge
	PCBA	12	1.5	E. side of Route # 2 bridge No sample
	PCWB	12	1.3	Center of Route # 2 bridge
	PCBB	12	1.8	Center of Route # 2 bridge
	PCWC	12	1.6	W. side of Route # 2 bridge
	PCBC	12	2.1	W. side of Route # 2 bridge
PUCE RIVER				
	PRWA	10	0.6	W. side of Route # 2 bridge
	PRBA	10	1.1	W. side of Route # 2 bridge
	PRWB	10	1.0	Center of Route # 2 bridge No sample
	PRBB	10	1.5	Center of Route # 2 bridge
	PRWC	10	1.1	E. side of Route # 2 bridge
	PRBC	10	1.6	E. side of Route # 2 bridge
BELLE RIVER				
	BRWA	15	0.7	W. side of R.R. bridge N. of Rt. 2
	BRBA	15	1.2	W. side of R.R. bridge N. of Rt. 2
	BRWB	15	2.9	Center of R.R. bridge N. of Rt. 2
	BRBB	15	3.1	Center of R.R. bridge N. of Rt. 2 No sample
	BRWC	15	0.7	E. side of R.R. bridge N. of Rt. 2
	BRBC	15	1.2	E. side of R.R. bridge N. of Rt. 2 No sample
RYSCOM RIVER				
	RRWA	13	1.7	W. side of Rt. 2 bridge
	RRBA	13	2.2	W. side of Rt. 2 bridge
	RRWC	13	1.7	E. side of Rt. 2 bridge
	RRBC	13	2.2	E. side of Rt. 2 bridge
THAMES RIVER				
	TRWA	25	--	2 miles upstream on the N. side
	TRBA	25	--	2 miles upstream on the N. side No sample
JEANNETTES CREEK				
	JCWA	20	2.3	E. side of R.R. bridge
	JCBA	20	2.8	E. side of R.R. bridge
	JCWB	20	2.5	Center of R.R. bridge
	JCBB	20	3.0	Center of R.R. bridge
	JCWC	20	0.5	W. side of R.R. bridge
	JCBC	20	1.0	W. side of R.R. bridge
BIG CREEK				
	BCWA	18	3.3	E. side of R.R. bridge
	BCBA	18	3.8	E. side of R.R. bridge No sample
	BCWB	18	2.3	Center of R.R. bridge
	BCBB	18	2.8	Center of R.R. bridge No sample
	BCWC	18	0.7	W. side of R.R. bridge
	BCBC	18	1.2	W. side of R.R. bridge No sample

TABLE 2 SAMPLE LOCATION AND DATA FROM U.S. RIVERS

SAMPLE		WIDTH	DEPTH (Meters)	LOCATION
CLINTON RIVER CUT OFF CHANNEL				
	CCWA	50	2.0	N. side of river Jefferson Rd. bridge
	CCBA	50	2.5	N. side of river Jefferson Rd. bridge
	CCWB	50	3.5	S. side of river Jefferson Rd. bridge No sample
	CCBB	50	4.0	S. side of river Jefferson Rd. bridge
CLINTON RIVER				
	CRAW	70	2.3	S. side of river off a boat dock
	CRBA	70	2.8	S. side of river off a boat dock
MILK RIVER				
	MRWA	8	1.8	Jefferson road bridge
	MRBA	8	2.3	Jefferson road bridge No sample

PROCESSING PROCEDURE

Twenty milliliters of one molar magnesium chloride was added to the water samples and then allowed to settle out in undisturbed gallon containers for four weeks. The MgCl was added to aid in the focculation (settling) of the clays. After the sediment settled out of suspension most of the water was decanted. To remove any organic content, the samples were treated with 20% hydrogen peroxide solution. To preserve any carbonates in the samples, 14 ml of ammonium hydroxide per liter of hydrogen peroxide was added to keep the reaction's pH above 7. Twenty ml of the hydrogen peroxide solution was added to the sample every 12 hours until the reaction with the organics ceased. The remaining liquid was then removed from the sample by centrifuging the sample. A freeze drier was used to dry the sediment samples completely. After freeze drying, the sediments were powdered and randomly mounted onto x-ray diffraction powder mounting slides. To expand the clays in the samples before x-ray diffraction, the slides were glycolated at 65 C for four hours. A Phillips diffractometer was used to run powder x-ray analysis on the samples. The x-ray patterns were ran from 3 20 - 50 20 at 35 kilovolts and 15 megaamps, 2 0 per minute, sixty inches per minute, and with a range of 500. CuK x-rays were used in the analysis.

Twenty grams of each bottom sample were processed for x-ray analysis. The bottom samples were digested in the same procedure as described above. After digestion, the samples were sieved into > 1 micrometer fraction, 1 - 250 micrometer fraction, 250 - 64 micrometer fraction, and < 64 micrometer fraction. The < 64 micrometer fractions were freeze dried and randomly mounted for x-ray diffraction and glycolated the same as the suspended water sediments. The samples were also x-rayed at the same setting as the suspended water samples.

MINERAL IDENTIFICATION

Minerals were identified by their characteristic basal x-ray diffraction peaks (see fig. 3). The d-spacing of the unknown minerals were determined from the diffractogram pattern and used to identify the mineral composition of sample (Chen, 1977). The area of the characteristic peaks were compared, to obtain an estimate of the abundance of the minerals in the sample. The greater the area of a characteristic peak on a diffractogram indicates a greater relative abundance of that mineral in the sample.

RESULTS

The minerals identified can be classified into three divsions, clay minerals, terrigenous minerals, and carbonate minerals. Four clay minerals were identified in the study. Illite, chlorite, montmorillonite, and smectite were identified in every sample, except in sample PRBC chlorite was absent. The abundance of the clay minerals varies from rare to very abundant. The terrigenous minerals indentified included quartz,

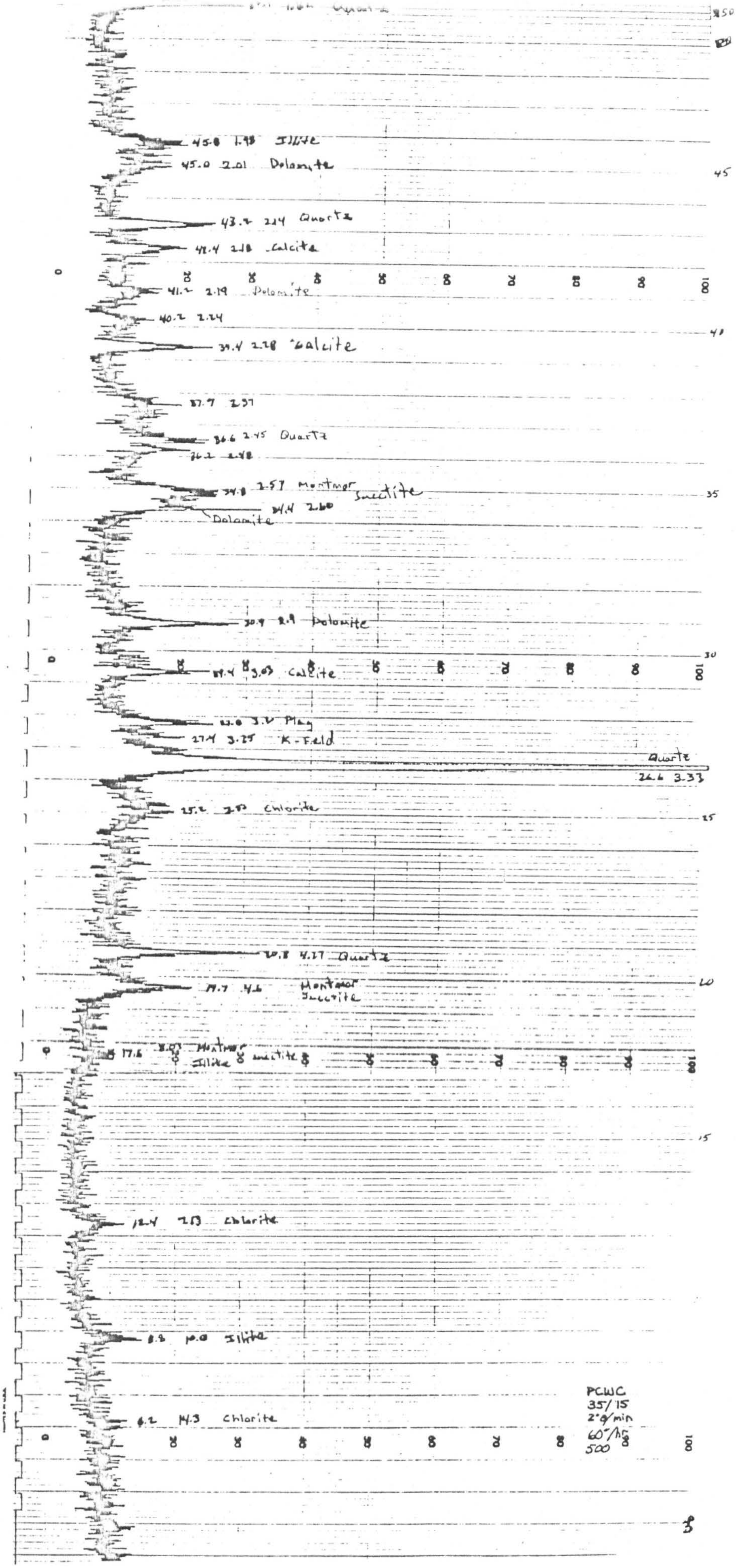

Figure 3. Sample x-ray diffraction pattern

plagioclase, and k-feldspar. Quartz varied from common to very abundant in abundance. Plagioclase and k-feldspar varied from absent to abundant. Calcite and dolomite were the carbonate minerals that were identified and they varied from absent to very abundant. The mineralogical composition of the samples are summerized on tables 3 and 4.

CONCLUSION

Qualitative mineral assemblages < 64 micrometers could not be used to identify the provenance of the fluvial (river) sediments in Lake St. Clair. This is because the mineral assemblages determined for the rivers and streams within the study all contain the same minerals. None of the rivers or streams contain significantly different minerals, which might be expected due to different erosional products from different provenances.

The Thames River, Jeannettes Creek, Big Creek and Ruscom River drainage basins are all above the Delaware Limestone Formation. Pike Creek, Puce River, and Belle River are above the Kettle Point and Hamilton shales (see fig. 4). A difference should be noticed in the mineral assemblages if the rivers are receiving sediments from these different bedrock types. The limestone would increase the relative abundance of the carbonate minerals and the shales would increase the clay minerals. Because of a relative lack of these mineral assemblages in the stream samples, the bedrock types must not be a significant source of the sediment. Therefore, the major source for the rivers and streams sediment must be the fairly uniform surficial deposits, mainly a till plain and associated lacustrine materials.

RECOMMENDATIONS

Since the preliminary study indicated no distinct qualitative differences in mineral assemblages in the < 64 micrometer size fraction,

TABLE 3 COMPOSITION OF THE SAMPLES FROM THE CANADIAN RIVERS *

SAMPLE	QUARTZ	ILLITE	CHLORITE	MONT.	SMECTITE	CALCITE	DOLOMITE	PLAG.	K-FELD.
PIKE CREEK									
PCWA	A	R	R	R	R	C	C	X	R
PCWB	A	C	C	A	C	C	C	R	R
PCBB	A	C	C	C	R	A	A	C	C
PCWC	A	C	A	C	R	C	C	C	C
PCBC	A	C	C	C	C	C	A	C	R
PUCE RIVER									
PRWA	A	C	C	A	C	C	A	R	R
PRBA	A	C	C	C	C	R	C	C	R
PRBB	A	C	C	C	C	C	C	C	R
PRWC	A	C	C	A	R	C	C	C	A
PRBC	C	C	X	R	R	C	C	C	R
BELLE RIVER									
BRWA	C	C	C	C	C	R	C	R	R
BRBA	VA	C	C	C	C	R	VA	C	R
BRWB	A	C	C	A	C	R	R	R	R
BRWC	A	C	C	A	A	C	C	R	X

*Note: VA = very abundent
A = abundent
C = common
R = rare
x = absent

TABLE 3 CONT.

SAMPLE	QUARTZ	ILLITE	CHLORITE	MONT.	SMECTITE	CALCITE	DOLOMITE	PLAG.	K-FELD.
RUSCOM RIVER									
RRWA	C	C	C	R	R	C	C	A	C
RRBA	A	A	A	C	C	C	C	C	R
RRWC	A	R	C	R	A	C	C	R	A
RRBC	A	C	C	R	R	C	C	X	X
THAMES RIVER									
TRWA	A	R	R	C	R	VA	A	C	X
JEANNETTES CR.									
JCBA	A	R	R	C	C	C	C	R	X
JCWB	VA	C	C	C	VA	A	A	C	R
JCBB	VA	A	C	C	VA	C	C	C	R
JCWC	VA	R	C	C	C	C	C	C	X
JCBC	A	R	R	R	R	C	C	C	X
BIG CREEK									
BCWA	C	C	C	A	C	VA	C	R	X
BCWB	VA	R	R	C	C	VA	R	R	X
BCWC	A	C	C	R	R	C	VA	C	R

*Note: VA = very abundent
A = abundent
C = common
R = rare
x = absent

TABLE 4 COMPOSITION OF THE SAMPLES FROM THE U.S. RIVERS *

SAMPLE	QUARTZ	ILLITE	CHLORITE	MONT.	SMECTITE	CALCITE	DOLOMITE	PLAG.	K-FELD.
CLINTON CUT R.									
CCWA	A	C	C	C	C	A	A	R	R
CCBA	A	C	C	R	R	C	C	C	R
CLINTON RIVER									
CRWA	A	R	C	A	C	C	A	A	R
CRBA	A	C	A	R	R	A	A	A	C
MILK RIVER									
MRWA	C	R	R	C	C	C	R	R	R

*Note: VA = very abundent
A = abundent
C = common
R = rare
X = absent

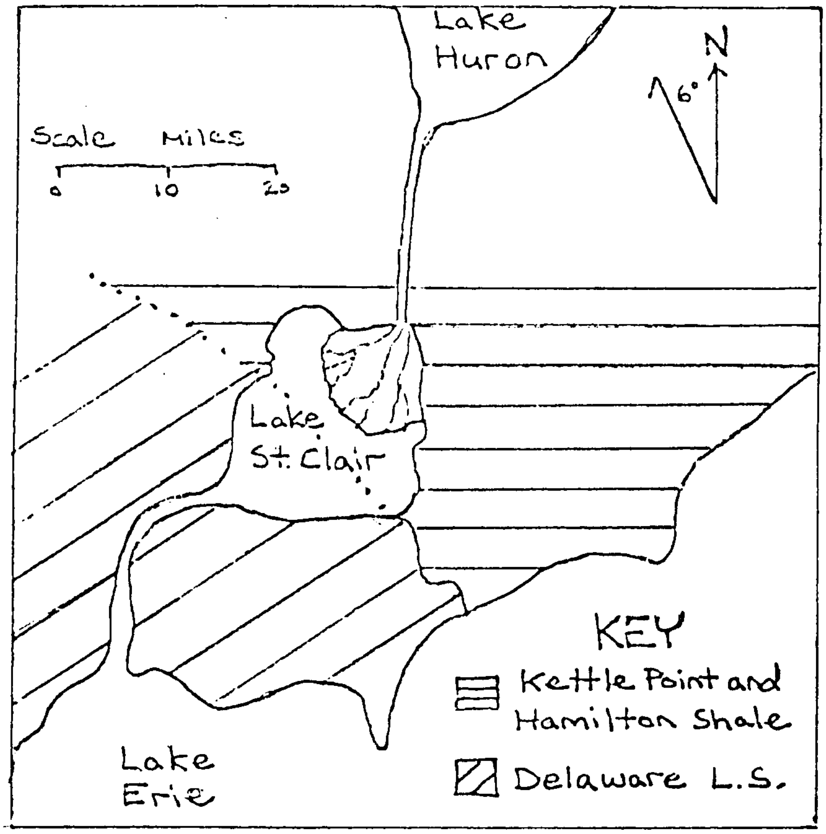

Figure 4. Bedrock Geology (McKenzie, 1964)

this study should be continued with a more detailed investigation including all size fractions, with a more quantitative analsis. Future sampling of sand and silt fractions should not be conducted from brigdes, because there is a possible source of contamination of the sediments from road debris falling into the water.

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