SOIL ANALYSIS AT THE ROBITAILLE SITE

Part I: Determining the Perimeter of the Village*

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INTRODUCTION

The work reported in this paper concludes that phase of the Robitaille soil investigations that deal with the delimitation of the village site. Most of the field and laboratory procedures as well as hypotheses and preliminary findings were published previously (Hurley and Heidenreich, 1969 and 1971). This report should therefore be regarded primarily as a conclusion to previous work rather than as a complete summary of the project.

ADDITIONAL FIELD AND LABORATORY WORK

After completing the phosphorus (P), magnesium (Mg), loss-on-ignition and pH tests on the samples gathered in the previous years all the samples were examined for their calcium (Ca) content.

Due to high chemical anomalies near the ends of some of the transects we felt it necessary to extend the transects in order to make sure we had passed beyond the perimeter of the village. The S transect was extended by 40 feet; the U transect by 20 feet; the T_2 transect by 120 feet and the Y transect by 130 feet. One new transect, Z, was run north-south across the ends of the S and U transects. Loss-on-ignition, pH, Ca, Mg and P tests were performed on all the new samples collected. The results presented in the figures of this report are therefore complete.

In order to speed up the process of collecting and processing samples all the new samples along the extended transects were taken at a standard depth of 10" below the A horizon. From our previous work we observed that this was roughly the area of maximum chemical accumulation (between 5" and 15" below the A horizon). The soil sections taken in the previous years were each sampled at a number of levels. This was a great deal of work which served to establish that it would have been sufficient for a project such as this to sample at only one or two levels. In order to make results from the previous years comparable to those from the new transects and samples, only the results from, at or near the 10" level will be considered in this report.

MAPPING PROCEDURE AND DESCRIPTION OF RESULTS

As in the previous years we decided to delimit the perimeter of the village on the basis of what we considered to be soils that had been significantly altered. Natural soils were collected under similar site conditions as the village soils about one quarter of a mile from the village. These samples were compared to samples taken within the village. Whether the differences between the means of samples of the natural and village soils were statistically significant was established by Student's "t" test. As pointed out in Cole and King (1968:124), the "t" test rests on an assumption that the standard deviations of the two populations are the same. This assumption can be tested by the variance ratio or F test. The results show that there are significant differences between the pH, Ca and P values of the natural and village soils, while the differences in the Mg and loss-on-ignition values were not statistically significant (Table 1).

In spite of the fact that the differences between the mean values in Mg and loss-on-ignition of the natural and village soils were not statistically significant we decided to include both for further analysis. Some of the village soils had high anomalies in loss-on-ignition (indicative of soil mixing) and Mg (ash lenses), while such isolated anomalies were not present in the natural soils. Anomalies in Mg and loss-on-ignition should therefore be regarded as additional evidence of soil modification rather than prime indicators.

Having decided that there are significant differences between natural and village soils, we decided to map these differences by plotting all the samples that were above the 95% and 99% confidence limits of the natural soils (Table 2).

Loss-on-ignition and pH anomalies are scattered mainly over the area enclosed by the middens, although some anomalies occur outside that area (Figure 1). On the whole we consider neither pH nor loss-on-ignition to be particularly useful in delimiting a village because their distributional pattern is not contiguous enough. There are too many samples within the area we know to have been occupied by the village that have normal pH and loss-on-ignition values. Both indicators may be used to establish the presence or absence of soil modification (providing the sample is large enough) but neither is good enough to delimit the perimeter of a village.

The distribution of P values shows that the high anomalies are not entirely concentrated in the area enclosed by the main middens (Figure 2). High anomalies are also found up to 60 feet beyond the middens, although these anomalies are not as contiguous as those found in the village area. By itself, P seems to be a useful indicator of soil modification although it is probably not sensitive enough to permit one to delimit the edge of a village with great accuracy.

As expected, Mg shows a very erratic distributional pattern (Figure 3). As will be shown in Part II of this report, Mg is an excellent indicator of ash lenses and shows great promise of being a significant tool for detecting house patterns; it's use in the delimiting a village however, is poor.

In our last report we postulated that for a number of reasons the Ca content of the village soils should be significantly higher than that of the natural soils (Hurley and Heidenreich, 1971: 207-211). At that time the analysis of the natural soils had been completed while that of the village soils had not been started. As can be seen from Figure 4 the difference in the vertical distribution of Ca between the natural and village soils is nothing short of spectacular. Similar to the vertical distribution of P, calcium accumulation is largely confined to the upper 20" to 25" of the soil profile, with the main accumulations resting at depths between 5 and 15 from the surface.

The horizontal distribution of Ca is similar to that of P except that Ca drops off more sharply beyond the main midden areas (Figure 5). Except for a few sample points, Ca values are uniformly high in the area between the middens, which one can be reasonably certain was occupied by the village. It appears therefore that Ca is one of the better indicators of soil modification as a result of human occupance.

Due to the fact that each indicator of soil modification is not entirely satisfactory on it's own in delimiting the village, an attempt was made to combine various indicators into a series of indices. In order to test the degree to which the various indicators are related to each other and thereby to determine which indicators can best be combined into an index, the various indicators were correlated to each other. Among the natural soils only pH and Ca, and Ca and Mg are correlated to a significant extent (Table 3). Amont the village soils Ca, P and loss-on-ignition are correlated to each other, while Mg is only correlated with P (Table 4). Correlations were also run with iron (Fe) and P (extracted in HC1). Of these Fe did not correlate significantly with anything else, while P (HC1) was correlated with loss-on-ignition, P(H2SO4) and Ca.

In formulating the indices pH was omitted because it did not correlate significantly with anything else, while loss-on-ignition was omitted because the loss-on-ignition values in the village did not differ significantly from those of the natural soils. Three indices were **constructed by** simply cross multiplying Ca, Mg and P (Ca x Mg; P x Mg; Ca x P). All figures were rounded off by four decimal places (10^{-4}). This procedure was carried out for both the natural and village soils whereupon the differences between the village and natural soils indices were tested for statistical significance (Table 5). Since the differences between the indices formulated for the natural and village soils were found to be significantly different, the 95%

and 99% upper confidence limits of the indices were calculated for the natural soils (Table 6) and used as a basis for mapping.

Figures 6, 7 and 8 depict the distribution of significant anomalies of P x Mg, Px Ca and Mg x Ca. All three Figures show essentially the same distributional pattern, namely that soil modification is greatest in the area between the main middens and in a 30 foot arc beyond them. Persistent anomalies occur well beyond the middens in the Y and Z transects.

SUMMARY AND INTERPRETATION

From the preceding discussion an attempt was made to summarize Figures 1 to 5 and Figures 6 to 8 into two figures outlining the areas of severest disturbance and thereby, hopefully, the perimeter of the village.

The distribution of pH, P, Mg, Ca and loss-on-ignition was summarized by arbitrarily assigning one point each time a sample point had an indicator above the 95% confidence limit and two points if an indicator was above the 99% confidence limit. The upper limit for each sample point is therefore ten. Again quite arbitrarily all samples above five points were considered to be in an area of primary disturbance and those below five points but above zero, in an area of secondary disturbance. The resulting distributional pattern (Figure 9) shows quite clearly that the area of primary disturbance is confined to roughly the area included by the main middens. Along the T_1 and Y transects an area of secondary disturbance extends for another 20 to 40 feet beyond the area of primary disturbance; this stretches to 60 feet along the T_2 transect and encompasses about 70 feet of the U and most of the S transects. Secondary anomalies are found along the R transect to the edge of the slope and well down the slope on the N transect. The anomalies on the valley slope down the N transect can be attributed to the downward movement of surface water and the erosion of midden material. The summary of the index values (Figure 10) was derived in the same manner as Figure 9. The distributional pattern depicting primary and secondary areas of disturbance is similar for both summary figures.

On the basis of the two summary figures it would seem that the most intensely occupied part of the village lay west of an arc passing near N-13, S-1, U-8, T2-8, Y-8, and T1-2. Since one could not expect village life to have been confined entirely to the village proper, one should expect some soil chemical anomalies scattered outside the most intensely occupied area. In other words, one should expect a transition zone between the most intensely occupied portions of a village and the relatively unmodified land beyond the village. Small, discontinuous anomalies along all the transects beyond the primary area of disturbance shows that the above hypothesis may be true; at least this seems to be the case along the N, T_1 Y and T_2 transects.

The scattered low anomalies along the R, S, Z and U transects are a bit of a puzzle because they extend for such a long distance beyond the primary area of soil modification (Figure 9 and 10). Three hypotheses may be put forth to explain the anomalies along these transects; all of these hypotheses could be tested in a week of archaeological field work. Hypothesis one is that the village perimeter extended through N12, R-21, S-16, Z-3, U-15, T_2-11, Y-17 and T_1-1, and that therefore the northeast section of the village in the vicinity of the S, U, and Z transects was less intensely occupied. The second hypothesis is that the anomalies along the R, S, U and Z transects represent an earlier occupational phase of the site. A third hypothesis could be that the site was not palisaded and that therefore one should not expect an abrupt break between intensely modified soils (village) and less modified soils (outside of village), but rather a broad transition zone. In view of the fact that a portion of a palisade has been excavated at the southwest corner of the site (Hurley and Heidenreich, 1969: 77) the latter hypothesis seems unlikely. A palisade can also be inferred from the erosional patterns along the slopes of the north facing valley (Hurley and Heidenreich, 1971: 228), and a strip of low soil anomalies in the area between N-13 and N-14 (Part II, this report). Which of the other two hypotheses is the most likely is difficult to say. In the process of the soils investigations three small middens were located outside the area defined by the archaeologists as the village (i.e.: west of middens A, C and D). One of these middens is centered on Z-6, another one in the vicinity of R-21 and a third about 25 feet north of S-10. These middens do not stand out as mounds; they are shallow and the midden material is thoroughly incorporated in the soil matrix. As a matter of fact we were not sure they were middens until the chemical analysis had been completed. Suppose we accept the first hypothesis, that the perimeter of the village passed through R-21, S-16, Z-3 etc., in other words, near the three small outer middens and that there was only one occupational phase. The question then becomes: why, unlike most other Huron villages, are the smallest middens located on the periphery of the village, and why was a good part of the village not very intensely occupied?

These questions are not really resolveable without some problem oriented archaeological work. At the moment however, we feel that, at least from the soils point of view, the second hypothesis presents the fewest problems. We therefore hypothesize a late phase, represented by a palisaded village occupying the area west of an arc running roughly through N-13, S-1, U-8, T2-8, Y-8, and T_1-2, and an earlier phase underlying the northern half of the late phase and extending to R-21, S-16, Z-3, U-15 and perhaps to T_2-11 and Y-17 (Figure 9 and 10). The three other middens and the scattered anomalies along the R, S, Z and U transects would therefore belong to an earlier occupational phase. This would account for the shallow, mixed nature of the middens and less intense nature of the anomalies along the R, S, U and Z transects. It should be added here that as early as 1969 we vaguely suspected an earlier occupational phase from the nature of the erosional sequences in the valley (Hurley and Heidenreich, 1969: 147-148).

The final proof or rejection of any of these hypotheses should come from further archaeological work. In particular we would recommend an examination of cultural material from middens A and C, which could in part date from an earlier phase, and the testing of the three small middens previously mentioned. A further point of interest would be to look for a palisade somewhere between N-14 and N-12, U-5 to U-8 and T2-5 to T2-8. Following this one might test the area between R-21 and R-22, S-12 to S-15 and U-12 to U-16 for a palisade or house patterns.

CONCLUSIONS

The purpose of this research was to demonstrate that soils analysis can be used as a significant tool in delimiting the areal extent of a Huron village. Due to the rapidity with which soil analysis can be carried out a great deal of information can be compiled about a village site prior to archaeological excavation. As a matter of fact we would suggest that soil analysis should precede archaeological work. The results from the soils work are general in nature and can be inconclusive without archaeological confirmation, yet they do provide a great deal of information on settlement patterns. At least for settlement pattern studies soils analysis prior to excavation could give the archaeologist greater direction in where to begin his excavations, and present him with a series of solveable hypotheses about the settlement that he might not otherwise be aware of. Archaeological work is by nature time consuming and very specific. Very detailed information can be gathered about a very small portion of a site in a single field season. In contrast soils analysis can provide very general information about a large portion of a site in a field season. It would seem reasonable therefore that in the season preceding actual excavation a soil survey of a site could present the archaeologist with a rough guide for his detailed excavations. Since the soil survey can be carried out with a minimum disturbance to the site there is little danger that valuable archaeological evidence would be obliterated. As will be shown in Part II of this report, a soil survey can also give the archaeologist a rough guide to the location of former longhouses.

The ideas presented in this report are not new in the study of prehistoric settlements. Geographers and archaeologists in Europe such as Arrhenius (1931), Lorch (1940), Guyan (1951), Gundlach (1961), and Abt (1968), as well as archaeologists in the United States such as Dietz (1957) and Deetz and Dethlefsen (1963) have used soil analysis to good advantage in settlement studies. The main difference between the studies mentioned above and the work done at the Robitaille site over the last few years is one of detail. The studies mentioned above have been mainly concerned with perfecting forms of chemical analysis and testing these methods to the extent of determining the presence or absence of a habitation site. We feel that at the Robitaille site we have carried soil chemical methods a step further by demonstrating their use in outlining the extent of a habitation site and pinpointing features of potential archaeological interest.

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TABLE 1
MEAN (X) VALUES IN VILLAGE AND NATURAL SOILS AND
THE STATISTICAL SIGNIFICANCE OF DIFFERENCES

	X, Natural Soil N = 24	X, Village Soil N = 36	Student's t - test	F-Values
pH	5.57	5.97	**	*
Loss-on-Ignition (%)	4.97	5.45	0	0
Ca (ppm)	643	1,927	**	**
Mg (ppm)	359	413	0	0
P (ppm) [1]	1,360	2,143	**	**

[1]) P extracted in 3N H_2SO_4

* significant at 0.05 level

** significant at 0.01 level

0 not significant at 0.05 level

TABLE 2
UPPER CONFIDENCE LIMITS OF NATURAL SOILS
(Sample Depth 10" + 4";N = 24)

	Mean Value	Standard Deviation	Upper Confidence Limits 95%	99%
pH	5.57	0.27	6.12	6.32
Loss-on-Ignition (%)	4.97	1.39	7.84%	8.85%
Ca (ppm)	643	185	1024	1160
Mg (ppm)	359	165	700	822
P(ppm) [1]	1360	314	2008	2238

[1]) P extracted in 3N H_2 SO4

TABLE 3

CORRELATION MATRIX: NATURAL SOILS

(Sample Depth, 10" + 4"; N = 24)

	pH	Ca	Loss-on Ignition	Mg	P(H2SO4)
pH	1.0000	0.5530**	-0.0961	0.3660	0.3783
Ca	0.5530**	1.0000	-0.1690	0.6892**	0.3483
Loss-on-Ignition	-0.0961	-0.1690	1.0000	-0.2443	0.1870
Mg	0.3660	0.6892**	-0.2443	1.0000	0.4022
P(H2SO4)	0.3783	0.3483	0.1870	0.4022	1.0000

* significant at 0.05 level
** significant at 0.01 level

TABLE 4

CORRELATION MATRIX: VILLAGE SOILS

(Sample Depth, 10" + 4"; N = 36)

	pH	Ca	Loss-on Ignition	Mg	P(H2SO4)
pH	1.0000	0.3152	-0.1429	0.2068	0.3313
Ca	0.3152	1.0000	0.6056**	0.0337	0.4383*
Loss-on-Ignition	0.1429	0.6056**	1.0000	0.1892	0.5579**
Mg	0.2068	0.0337	0.1892	1.0000	0.5321**
P(H_2SO_4)	0.3313	0.4383*	0.5579**	0.5321**	1.0000

* significant at 0.05 level
** significant at 0.01 level

TABLE 5

MEAN INDEX VALUES (X) IN NATURAL AND VILLAGE SOILS AND THE STATISTICAL SIGNIFICANCE OF DIFFERENCES

(Sample Depth, 10" + 4")

	X, Natural Soils N=24	X, Village Soils N = 36	Student's t-test	F-Values
Ca x Mg x 10^{-4}	25.1	80.8	**	**
P x Mg x 10^{-4}	50.9	97.1	**	**
Ca x P x 10^{-4}	88.3	457.1	**	**

* significant at 0.05 level
** significant at 0.01 level

TABLE 6

UPPER CONFIDENCE LIMITS OF INDICES FOR NATURAL SOILS

(Sample Depth 10" + 4"; N = 24)

	Mean Value	Standard Deviation	Upper Confidence Limits 95%	Upper Confidence Limits 99%
P x Ca x 10^{-4}	88.3	36.6	163.8	190.7
P x Mg x 10^{-4}	50.9	27.5	107.6	127.7
Mg x Ca x 10^{-4}	25.1	16.9	59.9	72.3