REPORT ON 1970 DRILLING

KIPLING TOWNSHIP, ONTARIO

KAOLINITIC SILICA SAND DEPOSIT

INDUSMIN LIMITED

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SUMMARY

In July and August 1970, 9 vertical holes with a total length of 1,490' were drilled on the Kipling township property of Indusmin Ltd.

Approximately 8 to 12 tons of Cretaceous kaolinitic silica sand and fireclay were collected for analysis.

Location of the property is illustrated in Figure 1, locations of the drill holes are illustrated in Figures 2 and 3. Figures 4 and 5 present cross-sections showing the interpreted structure of the deposit. Logs of the drill holes are presented in Appendix I, lists of samples taken are presented in Appendix II.

The total thickness of overburden, consisting of Recent and Pleistocene deposits overlying the Cretaceous units, varies from 60' to 112'.

The minimum thickness of 60' was encountered in

Hole 1: in other holes the overburden thickness ranges from 87' to 112', and averages 95'.

Previous drilling on this deposit, and on the similar deposit of Algocen Mines Ltd., has been carried out in winter when the frozen top portion of the muskeg permitted travel by heavy vehicles. Experience gained in the 1970 work showed that drilling on the Kipling township deposit is feasible in summer, and is indeed preferable to winter drilling.

INTRODUCTION

During July and August 1970 Indusmin Ltd. drilled 9 holes, with a total depth of 1,490', on the company's deposit of kaolinitic silica sand and fireclay located in Kipling township, Ontario.

Previous drilling, in 1959-60, had obtained poor sample recovery. A prime objective of the 1970 drill program was to obtain a large volume of silica sand and fireclay for analysis, and in this respect, the program was most successful.

The earlier drilling had shown that while overburden lying above the silica sands is commonly more than 100' thick, silica sands lie at a depth of 65' at the site of Hole M.R.4. The 1970 holes were drilled near M.R.4 to assess the extent of the area of relatively shallow overburden found in this hole.

The writer supervised the drilling and sampling program and logged the holes from July 24 to August 18, 1970.

This report summarizes geological features of the silica sand deposits, discusses some of the drilling techniques employed and the sampling procedures, and comments on some drilling and sampling problems.

LOCATION AND ACCESS

Kipling township is in northeastern Ontario, 120 miles northwest of Timmins. Figure 1 illustrates the location.

The village of Smoky Falls, a townsite maintained by Spruce Falls Power and Paper Co. Ltd., lies 9 miles south of the Indusmin property.

Smoky Falls is accessible from Smooth Rock Falls on Highway 11 by Highway 807 to a point near Abitibi Canyon, and thence by a private road owned by Ontario Hydro. The distance from Smooth Rock Falls to Smoky Falls is approximately 80 miles.

Roads from Smoky Falls permit a car to be driven to within 1 1/2 miles of the center of the 1970 drilling operations.

Spruce Falls Power and Paper Co. operates a private railway between Smoky Falls and Kapuskasing, a distance of about 50 miles.

HISTORY OF EXPLORATION

The presence of kaolinitic silica sands and fireclay in this area has been known for many decades.

In the winter of 1959-1960 American Nepheline Limited carried out a drilling program on the company's concession.

Thirteen holes were drilled in this program, 7 of these being located in Kipling township. The latter holes (numbered M.R.1 - M.R.7) were drilled to depths ranging from 100' to 221'. Their locations are shown in Figure 2, and abbreviated logs are presented in Appendix III.

A Joy 22HD core drill, casing and rods ranging in size from 6" diameter pipes to B rods, diamond and tricone bits were used in drilling, while Shelby and split tubes were used for sample recovery.

The chief problems encountered were difficulties in penetrating Pleistocene till, caving of the Cretaceous silica sand, and very poor sample recovery.

In the summer of 1960 2 shallow auger holes (numbers M.R.A.34 and 35)were drilled in the township. Their locations are illustrated in Figure 2, and summary logs are presented in Appendix III.

GENERAL GEOLOGY

Introduction

The general geology of Kipling township is illustrated in Figure 2.

The southern third of the township is underlain by Precambrian migmatite and diabase.

The northern two-thirds, including the area of current economic interest which is approximately defined by the drill hole locations shown in Figure 3, is underlain by Cretaceous kaolinitic silica sands, fireclay and other clays, and lignite.

Within the area of present economic interest, the kaolinitic silica sands are overlain by Recent and Pleistocene deposits, collectively referred to hereafter as overburden.

Table I presents a table of formations, Table II summarizes the thicknesses of the units encountered in both the 1970 and earlier drill holes.

Table I

Table of Formations

Recent	Muskeg
Pleistocene	Clay, silt, sand, gravel, till.
Cretaceous	Kaolinitic silica sand often containing pebbles and cobbles, fireclay, other clays, lignite.

Table II

Thicknesses of Units, Drill Holes 1-9, M.R.1-7

Hole	Recent	Pleistocene	Overburden (Recent + Pleistocene)	Cretaceous (minimum)
1	5'	55'	60'	102'
2	9'	103'	112'	30'
3	10'	84'	94'	106'
4	5'	91'	96'	76'
5	10'	80'	90'	83'
6	10'	86'	96'	36'
7	11'	89'	100'	102'
8	10'	80'	90'	90'
9	10'	77'	87'	40'
M.R.1	15.0'	193.0'	208.0'	13.5'
M.R.2	13.0'	59.0'+	72.0'+	
M.R.3	9.5'	85.5'	95.0'	106.0'
M.R.4	11.0'	54.2'	65.2'	124.8'
M.R.5	7.0'	93.0'+	100.0'+	
M.R.6	13.0'	87.0'+	100.0'+	
M.R.7	12.0'	88.0'+	100.0'+	

+ Minimum thicknesses. Holes M.R.2,5,6 and 7 did not reach the Cretaceous.

RECENT

Recent deposits consist entirely of muskeg: a mixture of moss, small shrubs, decaying vegetation, and water.

The muskeg ranges in thickness from 5' to 11', and for the most part is about 10' thick.

PLEISTOCENE

The Pleistocene deposits consist of interbedded, and often interfingering lenses, of clay, silt, sand, gravel, and till. Clay and till predominate. Details of the stratigraphy are presented in the drill hole logs, which comprise Appendix I.

The Pleistocene deposits range in thickness from 55' to 103'. The minimum thickness of 55' was encountered in Hole 1: elsewhere the thickness ranges from 77' to 103', and averages 86'.

In general these units are well compacted and dry. Many of the clays and tills are quite coherent, and frequently appeared in the sample as pieces of core rather than as loose particles.

The clays are most commonly dark gray to blue-gray in colour, less commonly they are brown. The Pleistocene clays are not plastic.

The silts and sands are brown in colour, and together with the gravels, form a very minor part of the Pleistocene section.

The tills consist of small pebbles, commonly less than 1/4" in diameter, embedded in a matrix of gray clay. Larger pebbles and cobbles occur but are not common. Boulders appear to be rare: only one boulder was encountered in drilling, in Hole 7.

CRETACEOUS

Introduction

The Cretaceous units consist largely of kaolinitic silica sand, lesser amounts of fireclay, very minor amounts of other clays, and a very thin band of lignite which was encountered in Hole 7.

Details of the Cretaceous stratigraphy are presented in the drill hole logs in Appendix I, and are illustrated on the cross-sections of Figures 4 and 5.

The total thickness of these units is unknown, as no drill hole has yet reached underlying formations. The maximum thickness of Cretaceous units cut in the 1970 drilling was 106', in Hole 3. In previous drilling, Hole M.R.4 cut 124.8' of these units.

KAOLINITIC SILICA SAND

The kaolinitic silica sand is a thick, milky-white slurry consisting largely of quartz grains, kaolin particles, and water.

The first few feet of the silica sand immediately underlying the Pleistocene deposits is commonly rusty or dark gray in colour, but this discolouration rapidly gives way to the normal milky-white colouration.

The quartz grains are sub-angular to sub-rounded, medium to coarse-grained, and are most commonly colourless to milky-white, with a very minor percentage possessing a yellow to yellow-brown surface stain.

Kaolin content of the slurry is difficult to estimate, but in general, kaolin would appear to comprise from 5 to 20% of the quartz-kaolin mixture. For the most part the

kaolin is white, and occurs as tiny particles dispersed throughout the sand. In certain cases, as noted on the logs and shown on the cross-sections, the kaolin content is noticeably higher than normal, and several of these richer zones appear to comprise beds that can often be correlated from hole to hole. In these richer beds, the colour is commonly pale brown to cream-brown, less commonly pale gray. The kaolin content is difficult to estimate, but would appear to be more than 30%. The kaolin-rich bands commonly proved difficult to penetrate with the drill. Thicknesses of the kaolin-rich bands ranged from 2' to 6'.

Water content of the slurry is also difficult to estimate: it appears to be of the order of 20% by volume.

Pebbles of quartz, clear, milky-white, and yellow-stained, are common. Pebbles of diabase, mafic metavolcanics, granite, and limestone are almost ubiquitous in the silica sands, and comprise a very small percentage of the sands.

Although previously unreported from the silica sands, cobbles were encountered in 4 of the 9 holes drilled. In the case of Hole 9 there is a slight suspicion that the cobbles may have come in part from the overlying Pleistocene deposits, but the cobbles encountered in Holes 2, 6, and 7 appear to be constituents of the silica sand. The cobbles are of diabase and granite, and were a great hindrance in drilling.

FIRECLAY

Beds of dense, plastic fireclay, ranging in thickness from 4' to at least 36' were encountered in 5 holes. The greatest thickness, 36', was encountered in Hole 3 where the hole ended in fireclay at a depth of 200'.

The fireclay is most commonly red to red-brown in colour, less commonly it is streaked red and white, or gray, brown to black, gray-white and brown.

In Holes 3 and 7, at depths of 124'-130' and 194'-200' respectively, there appears to be interbedding of fireclay and silica sand on a fine scale. This may be more a result of drilling technique than of actual interbedding, and these intervals may in fact be entirely fireclay. (The drilling techniques used and some associated problems are discussed in a later section).

OTHER CLAYS

Holes 3 and 4 cut beds of clay which appear to form a unit that is correlatable between these holes. The unit is 4' thick in Hole 3, 8' thick in Hole 4.

The clays are only very slightly plastic, are dark brown, dark gray to black in Hole 3, and sandy, gray to yellow brown in Hole 4.

As noted in the logs of Holes 6 and 7, a few lumps of black, presumably carbonaceous, sandy clay were found on the sample discharge pile after drilling. This material was not seen during drilling and sampling due to the large volume of sample material discharged. It may represent thin clay beds correlative with the bands described above.

LIGNITE

A 2'-thick band of lignite and black sandy clay was cut at a depth of 190' in Hole 7.

STRUCTURAL GEOLOGY

INTRODUCTION

Interpretations of the structure from drill hole data are presented in the cross-sections of Figures 4 and 5.

It should be noted that the dips of contacts in these figures are somewhat exaggerated as a result of shortening the horizontal spacing of holes in order to depict the holes on a conveniently-sized sheet. The true dips are more nearly horizontal than those shown. The sections do however portray accurately the suggested correlations of units from hole to hole.

OVERBURDEN THICKNESS

As indicated in Table II, the combined thickness of Recent and Pleistocene deposits ranges from 60' to 112'. The minimum thickness of 60' was encountered in Hole 1. Elsewhere, the overburden thickness is quite uniform, ranging from 87' to 112', and averaging 95'.

STRUCTURE OF THE CRETACEOUS UNITS

The relatively shallow overburden in the vicinity of Holes 1 and M.R.4 was previously interpreted as reflecting a structural dome in the Cretaceous units. The Cretaceous beds show no evidence of doming, and the shallow overburden at this site appears to reflect a pre-Pleistocene topographic high.

The interbedded, and recurring nature of the kaolinitic silica sands and fireclays is well illustrated in the cross-sections.

Unlike the fireclays of the similar Algocen Mines Ltd. deposit, which form persistent horizon markers, the fireclay beds of the Kipling township deposit cannot always be correlated from hole to hole. The fireclay beds appear to be lenticular, lensing out between some adjacent holes, and also to grade laterally into kaolin-rich beds of silica sand. An example of the latter is illustrated in Figure 4, Section Through Holes 9-1-5, where a thick fireclay bed in Hole 1, overlying silica sand and kaolin-rich silica sand, appears to be represented at a similar elevation in Hole 5 by a bed of kaolin-rich silica sand.

The bed of fireclay cut at the bottom of Holes 3,4, and 7 may well persist throughout the area, and may correlate with fireclay cut at approximately the same depths in Holes M.R.1 and M.R.3.

The correlation of dark-coloured, slightly plastic clays, in Holes 3 and 4, and possibly 6 and 7, has been noted earlier.

Cobbles in the silica sand tend to occur at approximately the same depths, and may reflect a cobble-rich zone or zones.

The kaolin-rich beds can be correlated from hole to hole in some cases: in others they lens out, or less commonly appear to grade into fireclay.

DRILLING

INTRODUCTION

Becker Drills Ltd., 194 Toryork Drive, Weston, Ontario, carried out the drill program. Initially a 3-man crew consisting of foreman, driller, and helper was supplied. The crew was

assisted for most of the program by a supervisor. When this number was found inadequate, a second helper was added. Drilling operations were carried out on 1 shift per day.

Before drilling commenced approximately 2 weeks were spent by the drill crew in moving equipment in, locating drill sites by compass-and-chain survey, and preparing platforms for the drill rig.

Nine vertical holes were drilled. Each had a planned depth of 200'. Due to drilling difficulties only 2 holes reached this depth. Depths attained ranged from 127' to 202'. Holes were stopped when excessive plugging or other difficulties made further progress too costly to be justified.

Drilling of the first hole started July 23, 1970; drilling of the ninth hole was completed August 18, 1970.

A total of 1,490' was drilled in 27 days. The average rate of progress over this period was 55.2' per day.

Depths of the holes and their dates of drilling are summarized in Table III.

Table III

Drill Hole Depths and Dates of Drilling

Hole	Date Started	Date Completed	Days to Drill	Depth
1	July 23	July 31	9	162'
2	Aug. 3	Aug. 5	2	142'
3	Aug. 5	Aug. 9	4	200'
4	Aug. 9	Aug. 10	1	172'
5	Aug. 10	Aug. 11	1	173'
6	Aug. 11	Aug. 12	1	132'
7	Aug. 12	Aug. 16	5	202'

Hole	Date Started	Date Completed	Days to Drill	Depth
8	Aug. 17	Aug. 18	2	180'
9	Aug. 1	Aug. 3	2	127'
		Total	27	1,490'

Average progress, July 23-August 18, = 55.2 feet per day.

Drill Hole Location

The sites of previous holes M.R.3 and M.R.4 were located in the field. Using M.R.4 as a central point, Becker personnel spotted the 9 holes by compass-and-chain survey.

Figure 3 illustrates the drill hole layout. Hole 1 was located 20' east of M.R.4: other holes were located at 1/4 mile (1,320') intervals in a square surrounding Hole 1.

Collar elevations of all the holes were assumed to be identical within ± 1'. The assumption is considered valid for the following reasons:

(a) the terrain is flat within the area drilled.

(b) given the spongy nature of the muskeg, a survey to determine elevations within narrow limits is impractical in summer.

(c) during the course of drilling a hole the rig commonly sank 1' to 2'.

On completion of a hole its site was marked by a squared pole, 8' to 10' high, painted fluorescent orange and marked with the hole number. In summer the drill hole sites will also be marked for some time to come by the pile of overflow silica sand at each hole.

Equipment Used

The drill employed was a Becker Center Sample Rotary drill, mounted on a tracked Flextrac-Nodwell frame. The rig has a gross weight of approximately 25 tons. Photographs of the rig and other vehicles used appear in Appendix IV.

The drill uses a rotating bit and drill stem, the latter consisting of 5 1/2" x 3 1/4" double-walled pipe. Compressed air at pressures of approximately 60 to 100 p.s.i. is blown down the hole between the pipe walls, exits through holes in the bottom of the bit, and returns to surface up the center of the pipe carrying with it the cuttings.

The air-sample mixture is carried by hose from the top of the drill stem to a cyclone mounted on the side of the rig, where the air pressure drops to atmospheric pressure and the sample drops out the bottom for collection. (see photographs in Appendix IV).

A service truck, also mounted on a Flextrac-Nodwell frame, and weighing about 15 tons, was provided.

A small Bombardier was used for travelling from the end of the car road to and from the drill sites, and for transportation of equipment and samples.

Travel on Muskeg

In general, travel with these vehicles on the muskeg was easy, and few difficulties were encountered.

No trouble was encountered in moving from drill site to site, and the moves were generally accomplished within 15 to 30 minutes.

Repeated travel over a route on the muskeg results in breaking of the thin surface mat of interwoven roots, and the vehicles then are liable to sink in the muskeg. Serious trouble was encountered only once during the program, when repeated travel by the service truck near Hole 7 led to digging of a deep trench in which the truck sank several feet. In attempts to pull the truck out of its trench, the drill rig also became stuck, and 1 1/2 days were spent in getting the vehicles out.

Rate of Penetration

As noted earlier, the average rate of penetration during drilling of the 9 holes was 55.2' per day.

Under ideal conditions, with no delays due to trouble, the maximum observed rate of progress was 1.6' per minute, obtained in drilling from 0' to 72' in overburden.

In drilling silica sand, somewhat similar rates were often achieved over short distances of up to 15'.

COMMENTS ON SOME DRILLING TECHNIQUES AND PROBLEMS

In drilling the holes drill pipe in 15' lengths was added to the stem until a total of 165' was reached: thereafter 10' lengths were added.

When a new pipe was added it was necessary to reduce air pressure to zero. At these times the high hydrostatic pressure existing in the silica sands often forced the sand into the bit and drill pipes. Frequently it was impossible to blow or shake this material loose, and in order to clear the stem, it was necessary to pull all the pipe from the hole and clean the pipe and bit at surface.

Dense Pleistocene clays and tills, Cretaceous fireclay and kaolin-rich beds of silica sand all caused the bit to become plugged with cored pieces of these materials. Such plugs were often loosened by quickly raising and lowering the stem; while at the same time jerking the stem by alternately starting and stopping rotation of the stem; and alternately raising and lowering the air pressure. If these measures were not successful it was necessary to either raise the stem a few lengths, and with loading poles lowered down the pipe, try to ram the plug loose, or pull the entire stem out and clean the bit at surface.

It was noted earlier that units classed as interbedded fireclay and silica sand might in reality consist entirely of fireclay. This apparent interbedding, as seen by mixed sand and fireclay in the sample, can be caused by raising and lowering of the drill stem in an attempt to free a plug in fireclay. The fluid silica sand moves to the bottom of the hole, and when the stem is raised and the plug comes loose, the fireclay and sand are discharged together from the cyclone.

Cobbles proved very troublesome. They frequently lodged in the U-shaped pipe at the top of the drill stem, as well as at various points in the pipe and in the bit. When lodged in the pipes, they could only be dislodged by hammering with a standard rock-drill rod or a loading pole, frequently a very time-consuming job.

Experience gained in drilling Hole 9, the second hole drilled on the pre-surveyed grid, influenced decisions on the stopping of Holes 2 and 6 when excessive troubles

were encountered with cobbles.

Hole 9 reached its maximum depth of 127' when the hole first plugged with a cobble. After raising the bit to surface and cleaning it, the stem was put back down. At a depth of 115' it again plugged with a cobble (presumably fallen in from above or pushed up by pressure of the sand). The bit was raised to surface, cleared, and the stem lowered to 103', when it again plugged with a cobble. A full day spent in trying to get past 127' resulted in the loss of 24' of depth.

The sand-blasting effect of the silica sand quickly wore holes in the original U-shaped hose at the top of the drill stem. The hose was replaced with a heavy pipe, but this also was soon worn through, and required frequent patching.

Cuttings are transported very rapidly from the bit to the cyclone discharge point. In those cases where no plugging occurs, the average travel time between cutting of material at the bit and its appearance at the cyclone appears to be about 5 to 20 seconds.

LOGGING

The drill hole cuttings were most commonly logged as the sample material was discharged from the cyclone. In some cases when penetration of the Cretaceous units was proceeding very rapidly, the writer assisted the drillers in collecting and moving the samples, and the material was logged from the samples at the end of a run of pipe.

The drill pipes were marked at 2' intervals. With these markings and the extremely rapid appearance of cuttings,

the contacts logged are believed to be accurate to within 1'.

SAMPLING

Introduction

Prime objective of the drilling and sampling program was to obtain as much of the Cretaceous kaolinitic silica sand and fireclay as possible for analysis. In this the program was most successful: an estimated 8 to 12 tons of these materials were collected.

Appendix II presents lists of the samples collected from the drill holes.

Material Sampled

From Hole 1, samples were taken of the Pleistocene and Recent deposits as well as of the Cretaceous deposits.

Samples of the Cretaceous units only were taken from Holes 2 to 9 inclusive.

Sample Interval

Samples were taken so as to represent a 2' interval. Given the often rapid progress of the drill over short intervals; the mixing of the sample material that occurs in the drill stem and cyclone; the difficulty of picking contacts with an accuracy greater than 1'; it was felt that a 2' sample interval was the minimum interval that would give acceptable accuracy.

The only exceptions to the 2' sample interval occur in the case of samples from the upper part of Hole 1, where the first 21' of Pleistocene clays and sands were sampled at irregular intervals, and in the case of the last sample taken from Hole 5, which represents a 1' interval.

SAMPLING PROCEDURE

Samples were caught in 5 3/4 gallon-capacity galvanized tubs placed below the cyclone (see Photos, Appendix IV)

As each 2' marker on the pipe entered the ground a new tub was inserted beneath the cyclone, and the filled tub was dragged aside for bagging.

To reduce the possibility of plugging due to delays caused by sampling and bagging, it was found best to run a length of pipe down without stopping for bagging. The samples representing the pipe-length were caught and dragged aside in order, a new length of pipe placed in the drill stem as quickly as possible and air circulation restored if possible. The drillers then assisted in bagging and stacking the samples.

By calculation a 2' interval of drill pipe displaces about 2.5 gallons of fluid.

Owing to the high hydrostatic pressure existing in the buried silica sands, much more sample was obtained than would be expected from calculation.

In drilling through silica sand a 5 3/4 gallon tub was usually filled in 10 to 20 seconds, long before the drill stem had progressed 2'.

In these cases, the tub was placed so as to catch a portion of the cyclone discharge, and a nearly full tub was commonly taken for the sample. A tubfull of silica sand slurry had an estimated weight of about 100 lbs.

Samples were poured into heavy plastic bags, which when filled weighed an average of approximately 50 lbs.

Samples from Hole 1, down to and including that representing the interval 122'-124', were put in 1 bag each, with the exception of the interval 26'-28' which required 2 bags.

Beginning with the sample representing the interval 124'-126', Hole 1, and thereafter, 2 bags were used to hold each sample. Exceptions to this generality are noted in the Lists of Samples, Appendix II. Each bag was marked with the hole number, footage represented, and as either "1 of 2" or "2 of 2".

Because of the method of collecting the samples, the 2 bags representing a 2' interval cannot be considered as each representing 1' of the 2' interval. The 2 bags comprising each sample should be composited before analysis, or if analyzed separately, their results should be averaged to obtain the proper analysis of the sample.

Rapid settling of the silica sand occurred in the tubs, while much of the kaolin remained suspended in the water portion of the sample. As a result, the first bag filled, "1 of 2" in each case, contains a higher proportion of water and suspended kaolin than does bag "2 of 2".

In drilling the similar Algocen Mines Ltd. deposit, there appeared to be significant loss of kaolin in water overflowing from sample containers (C.I.M. Bulletin, July 1970, p. 802).

The method of sample collection used in the 1970 program, and the bagging of the entire sample are believed to have kept the loss of water-suspended kaolin to a minimum.

When the bagged samples were allowed to stand for a few hours it was seen that the suspended kaolin separated from the water. It was hoped that the water could be poured from the bags, but it was found that the kaolin flashed into suspension when this was attempted. In future work, providing that manpower and time are available, it might be possible to carefully siphon much of the water from the settled samples.

As noted earlier much more silica sand is obtained than would be expected from the size of the hole, owing to its fluid nature and the high hydrostatic pressure obtaining in the buried sands. Given this feature, and the above-noted drilling techniques, when drilling in silica sand there is usually a copious and continuous out-pouring of silica sand from the cyclone. As only a portion is retained for samples a heap of wet sand rapidly builds up to a depth of 2 to 3' near the cyclone, as illustrated in several photos of Appendix IV.

With the uncertain footing this caused, and the weight of the filled tubs (about 100 lbs.), sampling and bagging were arduous. It was found that a minimum of 3 men was necessary to collect and bag samples at a rate permitting drilling to proceed efficiently. In order to decrease the time spent bagging samples, and so decrease chances of plugging, 1 or 2 of the other drillers often assisted the 3 men regularly engaged in sampling and bagging.

GENERAL ASSESSMENT OF DRILLING EQUIPMENT USED IN 1970 PROGRAM

It was noted earlier that with the drilling equipment used in 1959-60, difficulties were experienced in penetrating the Pleistocene tills, with caving of the holes in silica sand, and that sample recovery was very poor.

The drill used in 1970 had little trouble penetrating the Pleistocene deposits. Difficulties occurred in drilling the silica sands, as discussed earlier, but it is difficult to conceive of a drilling method that would not experience troubles in drilling this material. Sample recovery was excellent.

A direct comparison of sample recoveries from Holes M.R.4 (1959-60) and 1 (1970) illustrates the superiority of sample recovery in the 1970 work.

The log of Hole M.R.4 reports Cretaceous sands from 65.2' to 190.0', the end of the hole, with a thin bed of fireclay at 132.0'.

Hole 1, located 20' east of M.R.1, cut 17' of continuous fireclay from 123'-140', the same bed which from the poor sample recovered in M.R.4 was reported as a thin bed, presumably less than 1' in thickness.

A Becker Hammer Drill was used to drill the Algocen deposit. Considerable trouble was experienced with this drill in penetrating Pleistocene tills and in pulling pipe from the hole. Neither of these troubles were experienced with the Center Sample Rotary rig used in 1970.

The Center Sample Rotary drill has proved to be the most efficient type of drill yet tried for penetrating the silica sand deposits, and if further drilling is planned, it is recommended that this type of drill be used.

Respectfully submitted,

P. E. Giblin

November 30, 1970.

P. E. Giblin.

References

1. Report on the Moose River Project, 1959-60. By V. A. Haw, November 30, 1960, report to American Nepheline Ltd.

2. Silica-kaolin deposits of Algocen Mines Limited. By D. E. Smith and M. K. Murthy, Bulletin C.I.M. July 1970, p. 799-809.

Appendix I

1970 Drill Hole Logs

Hole 1

Location: 20' east of Hole M.R. 4.

Elevation: same as M.R. 4 ± 1'.

Depth: 162' Dip: -90°.

Started: July 23, 1970. Completed: July 31, 1970.

Log

Interval	Description
	Recent
0-5	Muskeg
	Pleistocene
5-60	Gray clay, minor sand interbeds.
	Cretaceous
60-123	Kaolinitic silica sand. 60-68: gray, probably due to contamination from overlying gray clay; thereafter is gray-white. 96-98: kaolin-rich section.
123-140	Fireclay. Red, dense, plastic.
140-162	Kaolinitic silica sand. Samples from 140-150 are discoloured red due to contamination from overlying fireclay. 142-144: kaolin-rich section.

End.

Note: Black friction tape, used by drillers for temporary repair on chuck sleeve, often appeared in samples down to 124'. Use of tape discontinued thereafter. Tape fragments can probably be screened out of dried samples.

Hole 2

Location: 1,320' west of Hole 1.

1,320' north of Hole 1.

Elevation: same as Hole 1 ± 1'.

Depth: 142' Dip: -90°.

Started: August 3, 1970. Completed: August 5, 1970.

Log

Interval	Description
	Recent
0-9	Muskeg
	Pleistocene
9-112	Gray clay, silt, sand, gravel, till. 9-18: gravel, cobbles, minor gray clay. 18-40: gray clay. 40-52: gray-brown silt. 52-55: gravel. 55-71: till, small pebbles in dense gray clay matrix. 71-76: silt and sand, wet. 76-78: till, as described above. 78-86: sand. 86-96: gray clay. 96-112: sand and gravel, wet.
	Cretaceous
112-142	Kaolinitic silica sand. In general, appears to have lower kaolin content than material from Hole 1. 122-142: numerous cobbles of various rock types occur in the silica sand.

End.

Hole 3

Location: 1,320' north of Hole 1.

Elevation: same as Hole 1 ±1'.

Depth: 200'. Dip: -90°.

Started: August 5, 1970. Completed: August 9, 1970.

Log

Interval	Description
	Recent
0-10	Muskeg
	Pleistocene
10-94	Gray clay, sand, gravel, till. 10-22: gravel, sand. 22-32: till. 32-94: gray clay, interbedded sand and gravel from 68-72.
	Cretaceous
94-124	Kaolinitic silica sand. 98-100: kaolin-rich section.
124-130	Fireclay and silica sand. Fireclay is red and brown; appears to be interbedded with silica sand in this interval; is moderately plastic.
130-158	Kaolinitic silica sand. Gray-white to 156, then is dark gray to brown due to presence of dark-coloured clay.
158-162	Clay. Brown, dark gray to black, only slightly plastic.
162-164	Kaolinitic silica sand. This section is relatively rich in kaolin.

164-200	Fireclay. Plastic. Predominantly red; sections characterized by other colours are: 174-178: gray 184-188: gray-brown to black 188-192: gray-white and brown.

End.

Hole 4

Location: 1,320' east of Hole 1.
1,320' north of Hole 1.

Elevation: same as Hole 1 ± 1'.

Depth: 172' Dip: -90°.

Started: August 9, 1970. Completed: August 10, 1970.

Log

Interval	Description
	Recent
0-5	Muskeg
	Pleistocene
5-96	Gray clay; silt, gravel 5-42: gray clay, not plastic. 42-70: silt, brown and gray-brown. 70-72: gravel. 72-74: silt. 74-96: gravel.
	Cretaceous
96-152	Kaolinitic silica sand. 96-106: dark gray in colour, probably due to contamination from overlying material; thereafter is markedly whiter. Also contains 1 to 2% pebbles of various rock types to 106'. 126-128: sample representing this section contains numerous lumps of cream-brown kaolin-rich clay. From aggregate thickness of lumps, clay bed is at least 0.5 feet thick, total thickness is less than 2 feet.
152-156	Clay. Yellow-brown, slightly plastic.
156-160	Clay. Gray, very slightly plastic; minor silica sand.

160-172 Fireclay.

Red and white in colour, plastic. Considerable silica sand occurs with the fireclay from 166-172, and probably the two are interbedded in this section.

End.

Hole 5

Location: 1,320' east of Hole 1.

Elevation: same as Hole 1 ± 1'.

Depth: 173' Dip: -90°.

Started: August 10, 1970. Completed: August 11, 1970.

Log

Interval	Description
	Recent
0-10	Muskeg
	Pleistocene
10-90	Gray clay, silt, sand, gravel, till. 10-45: gray clay. 45-52: silt, sand, gravel. 52-58: till, consists mainly of small pebbles in matrix of dense gray clay, contains few large pebbles and cobbles. 58-60: gravel. 60-90: gray clay.
	Cretaceous
90-173	Kaolinitic silica sand. Dry, well cemented with kaolin for first few inches, thereafter unconsolidated and very wet. 118-122: considerable cream-brown kaolin-rich clay.

End.

Hole 6

Location: 1,320' east of Hole 1.
1,320' south of Hole 1.

Elevation: same as Hole 1 ± 1'.

Depth: 132'. Dip: -90°.

Started: August 11, 1970. Completed: August 12, 1970.

Log

Interval	Description
	Recent
0-10	Muskeg
	Pleistocene
10-96	Gray clay, sand, gravel, till. 10-12: gray clay; a few cobbles at 10'. 12-14: gravel. 14-54: till, small pebbles in matrix of dense gray clay. 54-61: sand, gravel, silt. 61-96: till, as described above.
	Cretaceous
96-132	Kaolinitic silica sand. 96-104: gray-brown, probably due to contamination from overlying material; thereafter is gray-white in colour. 114: heavy flow of water. 118-132: many pebbles and cobbles of diabase, granite, and limestone occur in the silica sand.

End.

Note: A few lumps of black, presumably carbonaceous, sandy clay were noted on the sample discharge pile after drilling. This material was not seen during drilling and sampling due to the large volume of material discharged from the cyclone. The black clay should be readily detectable in the samples after they have been dried.

Hole 7

Location: 1,290' south of Hole 1.

Elevation: same as Hole 1 ± 1'.

Depth: 202'. Dip: -90°.

Started: August 12, 1970. Completed: August 16, 1970.

Log

Interval	Description
	Recent
0-11	Muskeg
	Pleistocene
11-100	Clay, sand, gravel. 11-15: gray clay. 15-16: gravel 16-30: brown clay 30-48: gravel, sand, boulders: diabase boulder at 32'. 48-54: till, small pebbles in matrix of brown and gray clay. 54-60: gravel. 60-68: sand, gravel. 68-94: clay, gray 68-78; brown 78-94. 94-100: gravel, sand.
	Cretaceous
100-190	Kaolinitic silica sand In general appears to contain relatively little kaolin. 118-120: numerous cobbles in sand. Sample 118-120' dark gray, probably due contamination from overlying material incurred during numerous "pull-backs" of drill stem in attempts to get through section 118-120'. 182-188: kaolin-rich section, cream-brown and gray-white clays. 188-190: silica sand, minor gray clay lumps. 190-192: Lignite, black clay, sand. 192-194: Fireclay. Brown-red, dense, plastic. 194-200: Fireclay and silica sand.

200-202: Fireclay.
Pale brown in colour.

End.

Note 1: A few lumps of black, presumably carbonaceous, sandy clay were noted on the sample discharge pile after drilling to 162'. This material was not seen during drilling and sampling due to the large volume of material discharged from the cyclone. It should be readily detectable in the samples when they have been dried.

Note 2: Due to prohibitive terrain conditions, this hole is located 30' north of its intended site, which was 1,320' south of Hole 1.

Note 3: This hole, and log, are composites of 5 holes drilled at and near the location given at the start of the log. Drilling and terrain conditions made it necessary to drill the hole as follows:

(a) 0'-32', at 1,290' south of Hole 1. Dip -90°. Stopped by boulder, moved to (b).
(b) 0'-82', at above site. Dip -85°; Bearing East. Stopped by excessive plugging; and excessive sinking of rig.
(c) 0'-162',50' west of above site. a,b,c, drilled August 12, August 13.
(d) 1st attempt to get past 162': hole (c) too badly caved to use, moved 5' west of site (c), drilled 0-82', plugged at 82'; service truck got stuck and dug a trench so deep as to make further drilling at this site impossible; in order to complete hole to desired depth of 200' moved to site (e).
(e) located 120' west of site (a), hole drilled from 0'-202'; sequence of units same as in earlier holes from 0'-162', sampled from 162'-202'. d and e drilled August 14-16.

Hole 8

Location: 1,320' west of Hole 1.
1,320' south of Hole 1.

Elevation: same as Hole 1 ± 1'.

Depth: 180' Dip: -90°.

Started: August 17, 1970. Completed: August 18, 1970.

Log

Interval	Description
	Recent
0-10	Muskeg
	Pleistocene
10-90	Clay, sand, gravel. 10-38: gray clay. 38-55: gravel, sand. 55-56: gray clay. 56-58: gravel, sand. 58-90: clay, brown and gray, with sandy lenses.
	Cretaceous
90-140	Kaolinitic silica sand 100-102: kaolin-rich, cream-brown. 136-140: kaolin-rich, cream-brown and gray. Between 136'-138', a cored-piece of kaolin indicates that minimum thickness of kaolin bed is 10 inches.
140-144	Fireclay. Red and brown.
144-180	Kaolinitic silica sand This section has a relatively high kaolin content. 152-158: kaolinitic silica sand is unusually viscous, suggesting a high kaolin content. 170-180: as from 152'-158', with lumps of gray kaolin-rich clay. 178-180: a few small lumps of dark brown, only slightly

Hole 8 continued -

plastic, sandy clay occur in the gray kaolinitic silica sand.

End.

Hole 9

Location: 1,320' west of Hole 1.

Elevation: same as Hole 1 ± 1'.

Depth: 127' Dip: -90°.

Started: August 1, 1970. Completed: August 3, 1970.

Log

Interval	Description
	Recent
0-10	Muskeg
	Pleistocene
10-87	Clay, till. 10-50: gray clay 50-87: till, small pebbles in matrix of gray clay.
	Cretaceous
87-127	Kaolinitic silica sand. Contains 1 to 2% of cobbles of a variety of rock types.

End.

Appendix II

Lists of Samples

Summary of Samples Holes 1-9

Hole No.	No. of Samples	No. of Bags
1	75	94
2	15	30
3	53	106
4	38	76
5	42	83
6	18	36
7	51	102
8	45	90
9	20	39
Total	357	556

List of Samples Hole 1

Muskeg: 0-5'

Gray clay & sand: 5-12', 12-14', 14-17', 17-20', 20-24', 24-26', 26-28', (2 bags), 28-30', 30-32', 32-34', 34-36', 36-38', 38-40', 40-42', 42-44', 44-46', 46-48', 48-50', 50-52', 52-54', 54-56', 56-58', 58-60'.

Silica sand, Kaolin: 60-62'
62-64'
64-66'
66-68'
68-70'
70-72'
72-74'
74-76'
76-78'
78-80'
80-82'
82-84'
84-86'
86-88'
88-90'
90-92'
92-94'
94-96'
96-98'
98-100'
100-102'
102-104'
104-106'
106-108'
108-110'
110-112'
112-114'
114-116'
116-118'
118-120'
120-122'

Silica sand, Kaolin and fireclay: 122-124'

Fireclay:	124-126'	- Note: beginning with this sample,
	126-128'	2 bags were used for each
	128-130'	sample. See attached notes
	130-132'	re sampling.
	132-134'	
	134-136'	
	136-138'	- Note: only 1 bag collected for
	138-140'	this sample.
Silica sand, Kaolin:	140-142'	
	142-144'	
	144-146'	
	146-148'	
	148-150'	
	150-152'	
	152-154'	
	154-156'	
	156-158'	
	158-160'	
	160-162'	

Total number of samples: 75
Total number of bags: 94

Note: Samples down to and including 122-124' may contain particles of black electric tape which drillers used as temporary filler in drill chuck. This material can probably be screened out.

List of Samples Hole 2

Silica sand, Kaolin:	112-114'
	114-116'
	116-118'
	118-120'
	120-122'
	122-124'
	124-126'
	126-128'
	128-130'
	130-132'
	132-134'
	134-136'
	136-138'
	138-140'
	140-142'

Total number of samples: 15
Total number of bags: 30

List of Samples Hole 3

Silica sand, Kaolin:	94-96'
	96-98'
	98-100'
	100-102'
	102-104'
	104-106'
	106-108'
	108-110'
	110-112'
	112-114'
	114-116'
	116-118'
	118-120'
	120-122'
	122-124'
Fireclay & silica sand	124-126'
	126-128'
	128-130'
Silica sand, Kaolin	130-132'
	132-134'
	134-136'
	136-138'
	138-140'
	140-142'
	142-144'
	146-148'
	148-150'
	150-152'
	152-154'
	154-156'
	156-158'
Clay	158-160'
	160-162'
Silica sand, Kaolin	162-164'
Fireclay	164-166'
	166-168'
	168-170'
	170-172'
	172-174'
	174-176'
	176-178'
	178-180'
	180-182'
	182-184'
	184-186'
	186-188'
	188-190'

Hole 3 continued -

Fireclay (continued)	190-192'
	192-194'
	194-196'
	196-198'
	198-200'

Total number of samples: 53
Total number of bags: 106

List of Samples Hole 4

Silica sand, Kaolin	96-98'
	98-100'
	100-102'
	102-104'
	104-106'
	106-108'
	108-110'
	110-112'
	112-114'
	114-116'
	116-118'
	118-120'
	120-122'
	122-124'
	124-126'
	126-128'
	128-130'
	130-132'
	132-134'
	134-136'
	136-138'
	138-140'
	140-142'
	142-144'
	144-146'
	146-148'
	148-150'
	150-152'
Clay, yellow brown:	152-154'
	154-156'
Clay, gray, & silica sand:	156-158'
	158-160'
Fireclay, red & white:	160-162'
	162-164'
	164-166'
Fireclay & silica sand:	166-168'
	168-170'
	170-172'

Total number of samples: 38
Total number of bags: 76

Note: Bag "1 of 2", 148'-150', appears to have been lost during transport of samples from drill site to storage site.

List of Samples Hole 5

Silica sand, Kaolin:	90-92'	
	92-94'	
	94-96'	
	96-98'	
	98-100'	
	100-102'	
	102-104'	
	104-106'	
	106-108'	
	108-110'	
	110-112'	
	112-114'	
	114-116'	
	116-118'	
	118-120'	
	120-122'	
	122-124'	
	124-126'	
	126-128'	
	128-130'	
	130-132'	
	132-134'	
	134-136'	
	136-138'	
	138-140'	
	140-142'	
	142-144'	
	144-146'	
	146-148'	
	148-150'	
	150-152'	
	152-154'	
	154-156'	
	156-158'	
	158-160'	
	160-162'	
	162-164'	
	164-166'	
	166-168'	
	168-170'	
	170-172'	
	172-173'	Note: 1 bag only for this sample

Total number of samples: 42
Total number of bags: 83

List of Samples Hole 6

Silica sand, Kaolin:	96-98'
	98-100'
	100-102'
	102-104'
	104-106'
	106-108'
	108-110'
	110-112'
	112-114'
	114-116'
	116-118'
	118-120'
	120-122'
	122-124'
	124-126'
	126-128'
	128-130'
	130-132'

Total number of samples: 18
Total number of bags: 36

List of Samples Hole 7

Silica sand, Kaolin:	100-102'
	102-104'
	104-106'
	106-108'
	108-110'
	110-112'
	112-114'
	114-116'
	116-118'
	118-120'
	120-122'
	122-124'
	124-126'
	126-128'
	128-130'
	130-132'
	132-134'
	134-136'
	136-138'
	138-140'
	140-142'
	142-144'
	144-146'
	146-148'
	148-150'
	150-152'
	152-154'
	154-156'
	156-158'
	158-160'
	160-162'
	162-164'
	164-166'
	166-168'
	168-170'
	170-172'
	172-174'
	174-176'
	176-178'
	178-180'
	180-182'
	182-184'
	184-186'
	186-188'
	188-190'

Lignite, black clay, sand:	190-192'
Kaolin-rich clay & silica sand:	192-194'
	194-196'
	196-198'
	198-200'
	200-202'

Total number of samples: 51
Total number of bags: 102

List of Samples Hole 8

Silica sand, Kaolin:	90-92'
	92-94'
	94-96'
	96-98'
	98-100'
	100-102'
	102-104'
	104-106'
	106-108'
	108-110'
	110-112'
	112-114'
	114-116'
	116-118'
	118-120'
	120-122'
	122-124'
	124-126'
	126-128'
	128-130'
	130-132'
	132-134'
	134-136'
	136-138'
	138-140'
Fireclay:	140-142'
	142-144'
Silica sand, Kaolin:	144-146'
	146-148'
	148-150'
	150-152'
	152-154'
	154-156'
	156-158'
	158-160'
	160-162'
	162-164'
	164-166'
	166-168'
	168-170'
	170-172'
	172-174'
	174-176'
	176-178'
	178-180'

Total number of samples: 45
Total number of bags: 90

List of Samples Hole 9

Silica sand, Kaolin:	87-89'	
	89-91'	
	91-93'	
	93-95'	
	95-97'	
	97-99'	
	99-101'	
	101-103'	
	103-105'	
	105-107'	
	107-109'	
	109-111'	
	111-113'	
	113-115'	
	115-117'	
	117-119'	
	119-121'	
	121-123'	
	123-125'	
	125-127'	Note: only 1 bag collected for this sample.

Total number of samples: 20
Total number of bags: 39

Appendix III

Summary Logs of 1959-60 Drill Holes

Summary Logs of 1959-60 Drill Holes

Locations of these holes are shown in Figure 2.

M.R.1

0-15.0	Muskeg, silt, sand
15.0-208.0	Pleistocene clay and till
	Cretaceous
208.0-218.3	Kaolinitic silica sand
218.3-221.5	Fireclay
End.	

M.R.2

0-13.0	Muskeg, silt, sand
13.0-72.0	Pleistocene till
End.	

M.R.3

0-9.5	Muskeg, silt, sand
9.5-95.0	Pleistocene clay and till
	Cretaceous
95.0-198.0	Kaolinitic silica sand
198.0-201.0	Fireclay
End.	

M.R.4

0-11.0	Muskeg, silt, sand
11.0-65.2	Pleistocene clay and till
	Cretaceous
65.2-190.0	Kaolinitic silica sand
	Thin bed of fireclay at 132.0
End.	

M.R.5

0-7.0	Muskeg, silt, sand
7.0-100.0	Pleistocene clay and till
End.	

M.R.6

0-13.0	Muskeg, silt, sand
13.0-100.0	Pleistocene clay and till
End.	

M.R.7

0-12.0	Muskeg, silt, sand
12.0-100.0	Pleistocene clay and till
End.	

Holes M.R.8 to 13 inclusive were drilled in other townships, and their logs are not summarized here.

M.R.A.34

0-6	Muskeg, silt, sand
6-48	Pleistocene clay and till
End.	

M.R.A.35

0-44	Logged as "may be partly Cretaceous."
End.	

Appendix V

Log of 1970 Drill Hole 10

Hole 10

Location: 3,960' south of Hole 1.

Elevation: same as Hole 1 ± 1'.

Depth: 202' Dip: -90°.

Started: August 19, 1970. Completed: August 19, 1970

Log

Interval	Description
	Recent
0-10	Muskeg
	Pleistocene
10-80	Clay and sand. 10-20: sandy clay 20-30: gray clay 30-40: wet glay 40-50: wet clay 50-60: wet clay and sand 60-80: clay
	Cretaceous
80-82	Fireclay
82-147	Kaolinitic silica sand 90-100: minor beds of kaolin 100-120: minor beds of fireclay 140-147: minor beds of fireclay
147-150	Fireclay
150-180	Kaolinitic silica sand 150-152: silty, gray 162-172: minor beds of kaolin
180-181	Fireclay
181-202	Kaolinitic silica sand 190-202: minor beds of kaolin

End.

Note: Hole logged by J. Veldman.

Appendix IV

Photographs

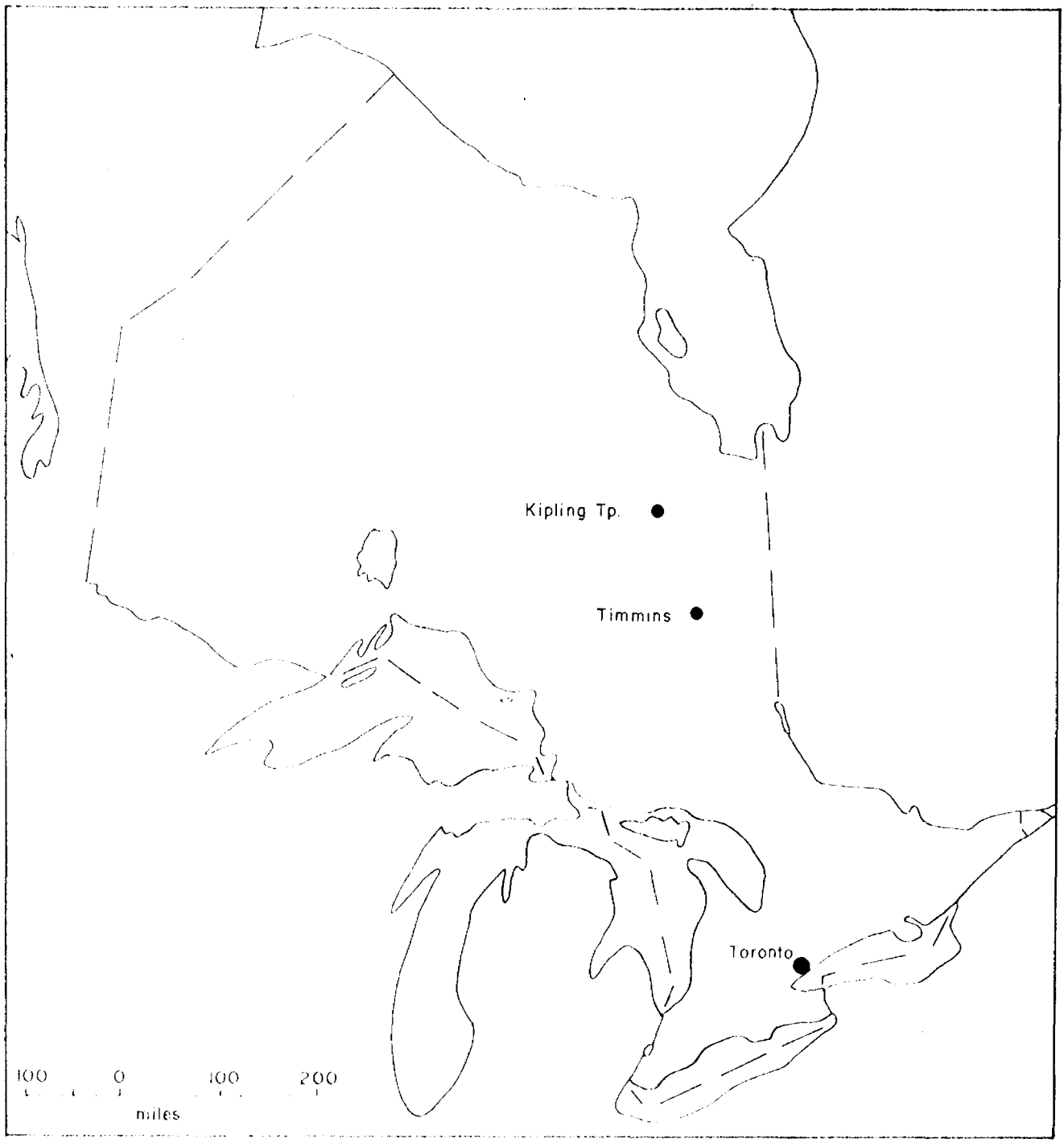
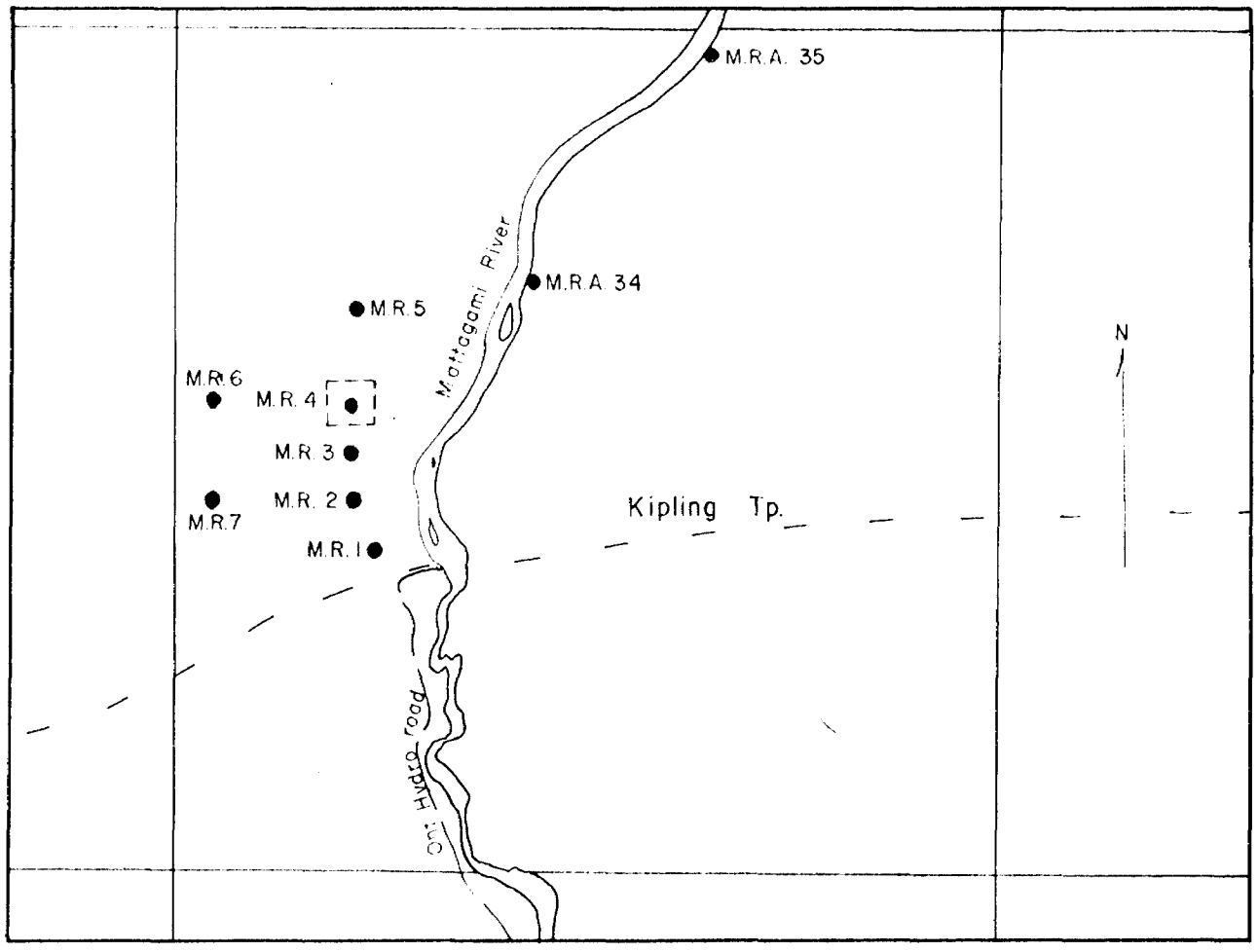


FIGURE 1

LOCATION OF KIPLING TP.



Scale: 1 inch = 2 miles

FIGURE 2

PLAN OF 1959-1960 DRILL HOLES IN KIPLING TP. AND GENERAL GEOLOGY

● M.R 4 1959-1960 drill hole location and number

Area of 1970 drilling, for details see Figure 3

LEGEND

RECENT AND PLEISTOCENE
Muskeg; Clay, silt, sand, gravel, till (not shown)

CRETACEOUS
Kaolinitic silica sand, fireclay, lignite

PRECAMBRIAN
Migmatite, diabase

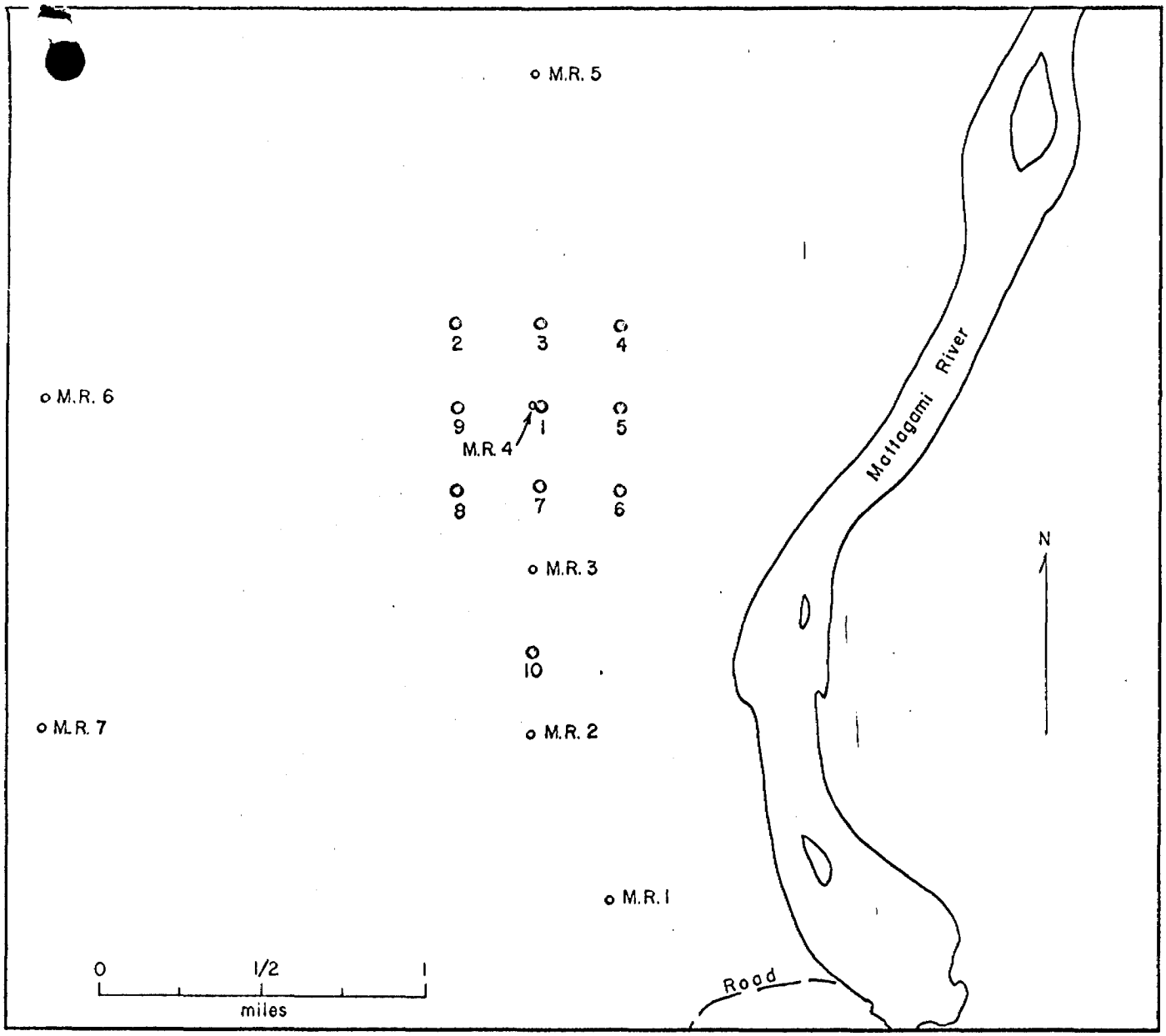


FIGURE 3

PLAN OF 1970 DRILL HOLES

3 1970 drill hole location and number

M.R.3 1959-1960 drill hole location and number

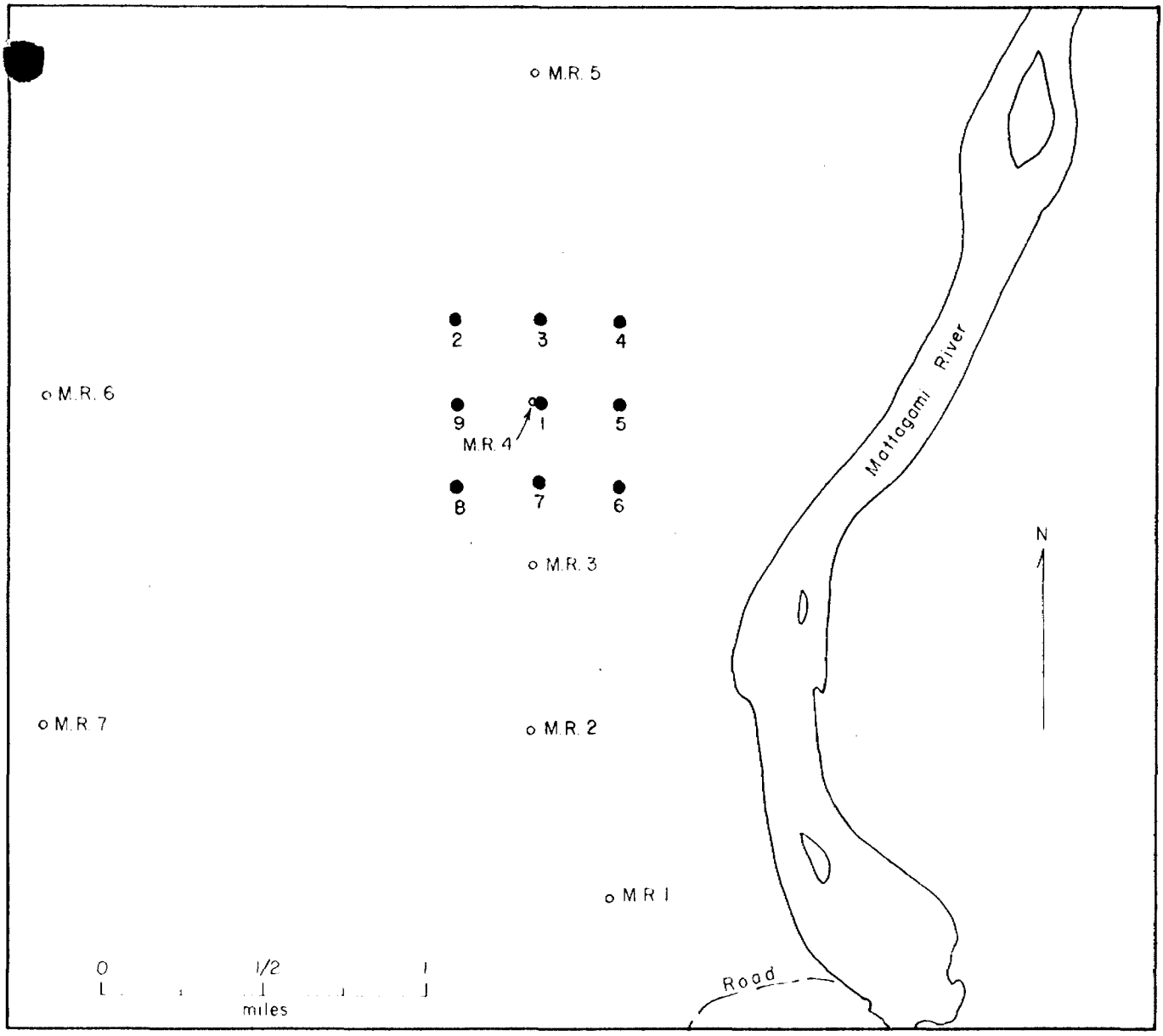


FIGURE 3

PLAN OF 1970 DRILL HOLES

● 3 1970 drill hole location and number

○M.R.3 1959-1960 drill hole location and number

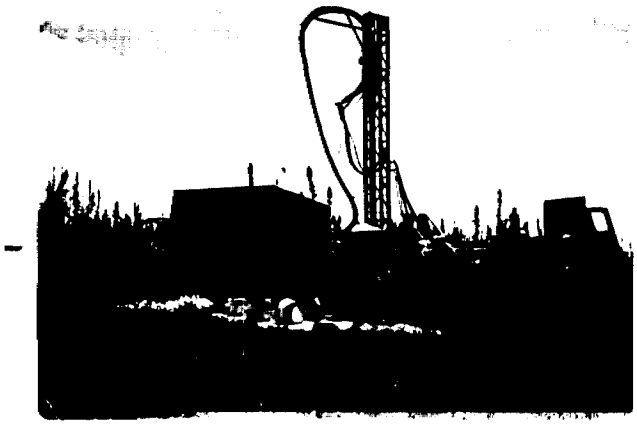


Photo 1 Drill rig and service truck. Hole 1

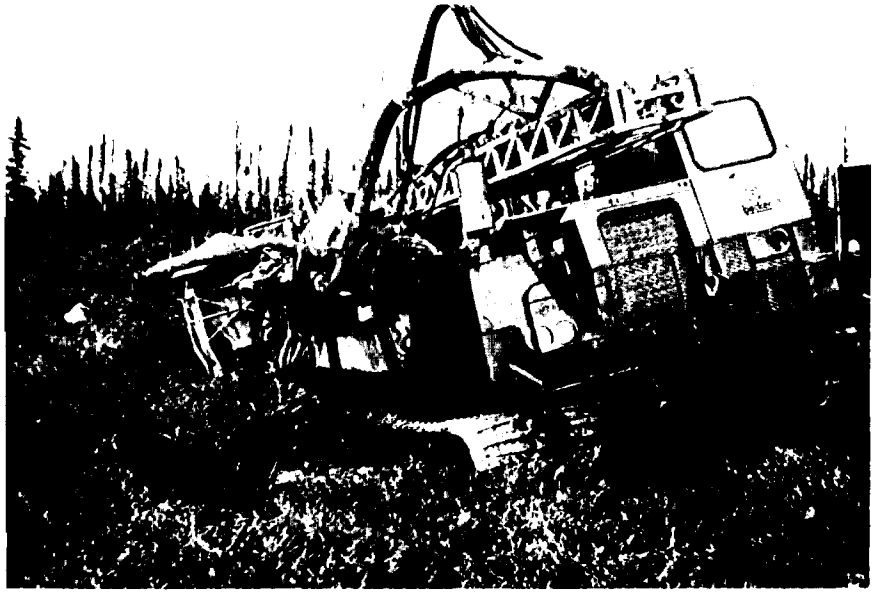


Photo 2 Drill rig in travelling configuration, bogged down. Hole 7

Photo 3 Side view of rig showing cyclone, tubs for sample collection, and overflow silica sand. Hole 1

Photo 4 Collecting fireclay sample. Hole 1

Photo 5 Scene at end of drilling Hole 1.

Photo 6 Service truck and rig bogged down. Hole 7

Photo 7 Cyclone discharging silica sand (moderate rate of discharge). Hole 7

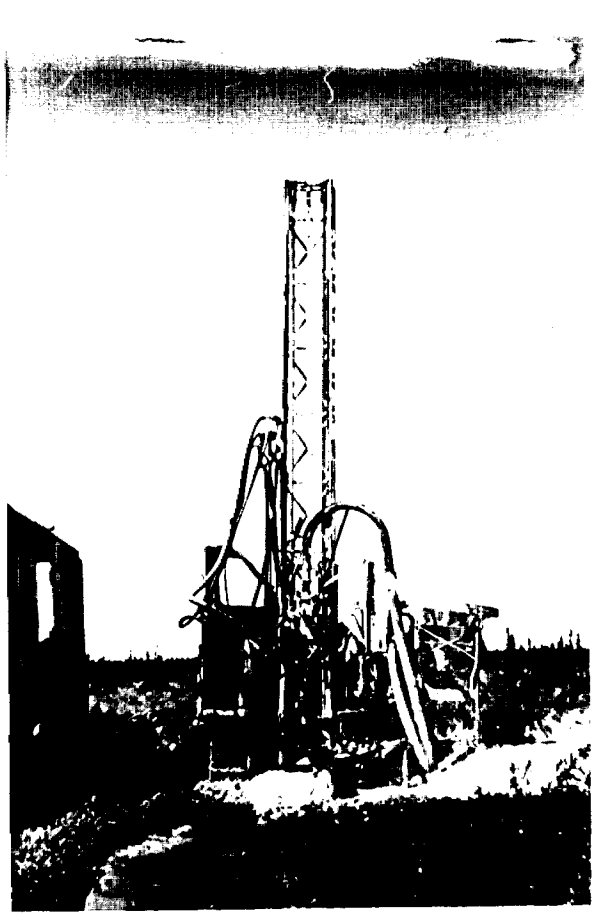


Photo 8 Drill rig in drilling configuration, Hole 8. Slight tilt of rig is due to differential sinking in muskeg.

Photo 9 Same scene as in Photo 8, illustrating spread of overflow silica sand.

REPORT ON THE MOOSE RIVER PROJECT

1959 - 60

BY

J. A. HOW

November 30, 1960

SUMMARY.

The Moose River project was carried out under the Industrial Minerals Division of Ventures Limited -- American Nepheline Limited. The purpose of the project was to find deposits of kaolin and associated clays and silica sands in the Moose River basin area of the James Bay lowland, which could be commercially developed. It was started in September 1959, and the last field work was completed on the 16th of September 1960.

A concession covering eleven townships, located about sixty miles north of Kapuskasing, was granted by the Ontario government to the company for the exploration program on conditions outlined in the report. A description of the concession is given, together with an outline of investigations carried out on previous government surveys and by private interests.

Two preliminary trips were made into the area by company officials and staff to obtain first hand information on field conditions prior to embarking on a full scale exploration program. The decision was made to proceed with a winter drilling program which got under way on December 2.

Thirteen holes were drilled on the eastern side of the concession during the course of the winter drilling under very difficult conditions. Drilling through glacial till and the unconsolidated silica sand, and the recovery of samples proved the chief obstacles. The long moves between holes together with severe winter conditions also were hazards which seriously delayed progress. The holes were drilled to depths of between 220 and 75 feet, although most of them were stopped at 100 feet. Three of them intersected Cretaceous silica sands and fireclays at depths of 206, 95, and 65 feet below surface. Penetration of the Cretaceous was almost entirely in sand to thicknesses of up to 125 feet. Minor amounts of kaolin were found dispersed in the sand, but the best concentrations were in the order of only 15-20 percent kaolin. The winter drilling ended on April 4, 1960.

The slow progress and the high cost of the winter program made it essential that a reappraisal of exploration methods should be made before further work was done. This culminated in a summer program of auger drilling to a depth of approximately 50 feet. Advantage was taken of the natural erosion of stream beds in collaring holes to obtain information at greater depth. Twenty-five holes were drilled between August 10th and September 26th, 1960. Cretaceous fireclays and silica sands were intersected in five holes. Two of these were entirely in fireclay, and the other three almost entirely in silica sand. Again, the silica sand contained minor kaolin, but not in sufficient quantity to be of any economic significance.

Drilling, together with examination of steep, high banks along streams showed that there is a uniformly thick blanket of overburden -- glacial till and stoneless clays, marine clay, and sand and gravel, covering the Cretaceous clays and sands. Some evidence appears to be of bedding structure indicating the concession area which suggests a thicker layer of overburden towards the central part.

Laboratory investigations were carried out on samples of the kaolin and silica sands to evaluate them for industrial use, and to determine quantities present. The results were not promising because of the poor colour and grit content of the kaolin, which would preclude its use as a paper filler -- its principal market.

CONCLUSIONS

A full account of all activities connected with the Moose River project have been described above. The results of the investigations have given no encouragement to continued work in the concession in the search for kaolin deposits.

It was evident from the beginning that success of the project would first of all depend on the finding of deposits of commercial grade kaolin. The recovery of silica sand and fireclay was a secondary consideration, although possibly an important one had any degree of success been achieved in the first objective.

No kaolin was found in the course of drilling which could be given any consideration for future development. Only in the one hole, DH 4, was it found in concentrations that showed any promise. But while kaolin contents of between 15 and 20 percent were obtained, these were restricted to vertical depths of only about two feet of several different and widely separated horizons. Large quantities of fireclay and silica sand were found, but these with their low unit value are of little importance on their own in the remote location of the Moose River basin.

The depth of overburden except in river valleys was found to be uniformly thick over the whole concession. This proved to be a greater obstacle to drilling than anticipated, and would be a serious handicap to mining operations.

An examination of the tax situation which might have affected the development of a property in the concession, showed that a kaolin operation would probably not receive favourable consideration by the Department of National Revenue with regard to depletion allowance or three year tax exemption.

Laboratory investigations into the properties of the kaolin recovered from the bore hole samples were not encouraging. The

colour and grit (quartz) content of the separated kaolin at five microns would make it unsuitable for use as a paper filler — about 75 percent of the kaolin market.

The conclusion must, therefore, be reached, that in view of the negative results briefly reviewed above, no further expenditures are justified on the Moose River project.

CONTENTS

INTRODUCTION

The search for kaolin in the Moose River Basin, in an area about 60 miles north of Kapuskasing, Ontario, was undertaken as a project of the Industrial Minerals Division of Ventures Limited – American Nepheline Limited in the summer of 1959. A concession of about 900 square miles was obtained from the Ontario government in which exclusive right was given for the exploration for kaolin, ball clay, fireclay, and silica sand, covering a period of three years.

Field work on the project got under way in September of 1959 by a reconnaissance trip down the Missinaibi River in the region of known deposits of Cretaceous fireclays and silica sands. This was followed by winter and summer drilling programs which ended the last of September, 1960.

This report describes the activities leading up to the exploration program, something on the methods used in the field work, and an account of the results obtained from drilling. It contains sections on geology, laboratory investigations, and a brief reference to tax considerations affecting development of kaolin deposits.

The report is also intended to serve as a final submission to the Ontario Department of Mines in partial fulfillment of the agreement on the granting of the concession.

Supplementing the report is a map of the concession, showing all drill hole locations, and drill hole sections showing the thickness and type of materials intersected in the drilling. Descriptive logs of the drill holes are available and copies of which accompany this report to the Ontario Department of Mines.

DESCRIPTION OF CONCESSION

The concession consists of a group of townships, Kipling, Acres, Wright, Gardon, McBrien, Durstall, McCausland, Hanlan, Amery, Mahoney, and Nabel, in northern Ontario about 100 miles south of James Bay, covering close to 900 square miles.

Location and Access

It is located in the James Bay Lowlands in what is generally known as the Moose River basin, lying between latitudes of 50°00' and 50°30', and longitudes of 82°00' and 83°00'. The southern margin occurs along the Precambrian-Paleozoic contact which lies about sixty miles north of Kapuskasing. The concession is flanked on the east by the Mattagami, and on the west by the Missinaibi rivers.

The only ground transportation to the concession is by the Spruce Falls Power and Paper Company private railway running between Kapuskasing and Smoky Falls, a distance of fifty miles. A bush road continues for eight miles from Smoky Falls to the bottom of Long Rapids on the Mattagami river in Kipling township, which lies on the southeast corner of the concession. The Ontario Northland Railway lies about thirty miles to the east of this point. The Canadian National Railways transcontinental line runs within forty miles to the south of [illegible] township on the southwest corner. For any satisfactory servicing of exploration activities in the area the use of aircraft was found essential.

The company had available for its own use a Super Cub aircraft which was equipped with floats for summer, and a combination ski-wheel landing gear for winter conditions. An aircraft base is located at Remi Lake, twelve miles east of Kapuskasing, which was used in the summer, and the field at Kapuskasing was available during the winter. Company personnel flew the plane so that air transportation costs were reduced to a minimum, in addition to greatly improving the convenience of transportation facilities. It was necessary to supplement our own flying by commercial charter service when transportation of heavy equipment was required. Mattagami Skyways, owned by Percy Bradley, operated a charter service out of Remi Lake during the period of our work on the project.

Physiography

The lowland area in which the concession occurs is a flat plain, sloping gently -- three to five feet per mile -- from the Precambrian escarpment to James Bay at sea level. The two major local rivers, the Mattagami and Missinaibi, with their tributary streams have cut deeply into the surface, in places 200 feet or more. Most of the rivers and streams are of the meandering type with shallow, swift running water except during spring run-off periods. The only high

ground is found adjacent to the river banks where thick growth ... spruce, poplar, and some pine, is fairly heavy and abundant. A few hundred feet back from the banks the ground gives way to marshy ... sparse to moderate growth of stunted spruce and tamarac. There are scattered small lakes in the concession area which permitted landings by the small aircraft, otherwise transportation around the concession was difficult except along the main rivers. Many of these features are illustrated in photograph no. 4 at the end of the section on timber cruising, which shows the aircraft, right foreground, on the Opasatika River.

General Geology

The Moose River basin concession is underlain almost entirely by Paleozoic sediments. The lowland is bordered by a low Precambrian escarpment on the south, and the shores of Hudson Bay on the north. There is some rock outcrop along the banks of the rivers where they have cut through the mantle of glacial till and unconsolidated sediments of recent age. These outcrops, together with deep drilling, show the Paleozoic rocks to be Silurian and Devonian sandstones, limestone, dolomite, and shales. Some local basins in the Devonian surface were filled with clays and silica sands of Lower Cretaceous age. These are to be found on the south side of the lowland, near the Precambrian escarpment. The concession occurs in an area underlain by one of these Cretaceous basins.

The geological history as interpreted by various government geologists, listed at the end of the report, indicates that after deposition of Silurian rocks followed by a period of erosion which removed the upper portion, Middle and Upper Devonian sediments — mainly limestone and dolomite, were deposited over the area. A very long period of erosion occurred through to Cretaceous time, when weathered products of the Precambrian uplands to the south were transported and deposited in local basins of the Upper Devonian land surface. These products are represented by the plastic kaoliny and kaolinitic silica sands found along the main rivers and tributary streams in the southern parts of the area, including the concession. Subsequent glaciation removed a large portion of these Cretaceous deposits and left a thick mantle of glacial till over almost the entire area. Deposition of sediments of Recent age — marine clays, silts, sand and gravel, in depressions on the old glacial surface has levelled the existing land surface to its present condition.

[illegible] Investigations

The fireclay deposits of the Moose River Basin were discovered by Dr. Robert Bell (1) and reported by him in the Report of Progress of the Geological Survey of Canada for 1877 and 1878. The discovery was made on Coal Creek, a tributary of the Missinaibi River, in Mattagami township. Further deposits were discovered in 1907 and 1910 by E. B. Borron (2), and borings were made to determine the economic possibilities of the clays and kaolinitic silica sands encountered. This was followed by a number of investigations by government and private interests, amongst which those of Keele (3), Dyer (4), and Crocker (6) are of most interest.

In 1919, Keele examined the area and was the first to recognize the age of the Cretaceous clays and sands as such, giving them the name 'Mattagami formation'. A survey of the James Bay lowland was made by W. S. Dyer in 1927-28 and provided a comprehensive picture of the geological relationships of the area, including a description of the structural basin in which the Cretaceous sediments were deposited.

He outlined the basin by the Precambrian escarpment on the south, the eastern edge being between the Mattagami and Missinaibi rivers, the western edge to the west of the Missinaibi river, and the northern limits being at least forty miles north of the Precambrian escarpment at one point. It was within the area covered by this basin that the concession townships were selected. The next, and for the purpose of this report, most important investigations were made by A. E. Crocker, who examined and sampled by drilling Cretaceous outcrops along the Missinaibi river. He obtained information on the upper sections of the Cretaceous fireclays and silica sands, and sampled them for laboratory evaluation.

Laboratory investigations were carried out on a great many samples of clay obtained from the field work described. Without going into detail it will suffice to say that the results indicated that the Cretaceous fireclays from several locations proved promising as ceramic raw materials. Most of the clays proved to have a uniformly high refractoriness with P.C.E.'s (pyrometric cone equivalents) of 30 and up, with some as high as 35. Fired colours, shrinkage, and

...quality compared favourably with commercial fire clays. The conclusions were that the fireclays from the Cretaceous deposits could be adapted to the production of a wide range of refractory shapes, in addition to stoneware, sewer pipe, and structural clay products.

Commercial Developments

The first claims in the area were staked by C. H. McCarthy of Elk Lake in 1917. These were located at the foot of Long Rapids on the east bank of the Mattagami river. They later became the property of Northern Ontario China Clay Corporation Limited. This company built a road into the property from the Ontario Northern Railway line at Old Gun Portage at the Abitibi river, and did some sampling of the clay deposits. Apart from some laboratory work, no further development was carried out and no clay or sand was produced on a commercial scale from the property.

In 1933 and 1934 General Refractory Products Limited undertook an extensive exploration and development program on a property of twelve claims on the west bank of the Mattagami river just below Long Rapids. Eighteen drill holes were bored to an average depth of 70 feet. A pit was opened into the fireclays from which 40,000 cubic yards of overburden was removed. The drilling showed thicknesses of up to 45 feet of fireclay to be present. This deposit was later leased to Mocassin Clays and Mining Limited, who in 1942-43 reported a small production of clay and silica sand.

General Refractory Products Limited also own a group of eighteen claims on the Mocassin river in Rebel township. No activities have been reported from this property other than assessment work. The General Refractory Products' properties are now owned by the F. W. Warren estate.

[illegible]

Several preliminary investigations and studies were made to the exploration program which are described in this section.

The occurrence of valuable clays and silica sands in the

[illegible] Bay [illegible] had been known for some time as already described [illegible]. It was evident, however, that no intensive exploration [illegible] for these materials had ever been carried out. Furthermore, a brief market survey was enough to show that Canadian requirements for both kaolin and silica sand were substantial, i.e. approaching [illegible] per year, and that they were being met almost wholly by imports. A closer look at the Moose River basin deposits, therefore, appeared warranted.

A trip was made by aircraft in July, 1959, by company personnel for the purpose of making a preliminary assessment of the area and to see at first hand some of the fireclay and silica sand [illegible]. The party was composed of Messrs. D. Craig, [illegible], H. F. Craig, and G. R. Guillet. The proposed concession area was flown and the fireclay deposit on the east bank of the Mattagami River, just below Long Rapids, was examined. This was followed in September, after the granting of the concession, by a reconnaissance trip down the Missinaibi river by G. R. Guillet and D. Craig. The trip was made between Little Long Rapids in Dewitt township to the mouth of the Opasatika, a distance of fifty miles, and is briefly described further on.

Concession Agreement

Negotiations were begun in July, 1959, between the company and the Ontario Department of Mines on terms for the granting of a concession in the Moose River basin area for the exploration of kaolin, fireclays, and silica sand. The licence for the concession was applied for in a letter of July 21, 1959, by Mr. D. Craig of the company to Mr. H. C. Rickaby, Deputy Minister, Ontario Department of Mines, in which the purpose of the concession was outlined as: "The immediate aim is the securing of lands necessary for the complete investigation of the various clays and silica sands believed to occur in the central portion of the Moose River watershed. The ultimate aim is the development of a large non-metallic industry based on such primary products as kaolin, silica sand, fireclay, and ball clay."

The granting of the concession, previously described, followed on September 1, 1959. The terms of the concession agreement made the following provisions:

1. The area of the concession to cover the eleven townships, Dewitt, McBrien, Gardon, Wright, Acres, Kipling, Avery, Hanlan, McCausland, Nebel, and Mahoney, a total of about 570,240 acres. The groups of patented claims in Kipling and Nebel townships were excepted.

2. The company was given exclusive right to carry on an exploration program for kaolin, fireclays, ball clay, and silica sands in the concession area for a period of three years subject to the following conditions:

   (a) The payment of an annual rent of $100, payable in advance, the first payment being due on September 1, 1959.

   (b) An agreement by the company to spend $125,000 over the period of three years on the program, which would include investigations and market surveys.

   (c) A report of the field investigation including the results of drilling and related work, to be submitted annually within thirty days of the anniversary of the agreement.

   (d) A report of expenditures incurred for all work covering the same twelve months as in (c) also to be submitted.

   (e) All core cuttings or samples to be made available for examination by officials of the Ontario Department of Mines.

3. Provision was made for lease or leases of a part of the concession area for the purpose of developing a commercial deposit.

Tax Considerations

Some study was given the question of tax concessions that might be applicable to an operation based upon commercial production of clay and sands from deposits in the area.

The questions of concern on taxation arise out of the two measures of tax relief accorded most other minerals being mined in Canada. These are the 33 1/3 percent of profits deductible from income tax for depletion allowance, and the three year tax exempt period. The depletion allowance of 33 1/3 percent is, however, only applicable to those types of operations defined in Regulation 1201 of the Income Tax Act which requires the deposit to be non-bedded, or consist of certain specific minerals, not including kaolin. The three year tax exempt period is covered by Section 83 of the Income Tax Act and it specifically omits the operations of sand pits, clay pits, and stone quarries from the benefits of the Act.

The company considered it important from the first to establish that the kaolin and silica sand deposits should receive all the benefits of the Income Tax Act as described above. After consultation with legal and fiscal authorities a brief was prepared and submitted to the Department of National Revenue on December 16, 1959, requesting confirmation of the company view that the deposits were not bedded within the meaning of the Act; and, that an operation would be recognized as a mine, and, therefore, benefit from the three year tax exempt period. A reply was received on January 14, 1960, from the Chief Assessor's Office, stating the Department of National Revenue was unable to meet the request. The negative reply was, as explained in the letter, the result of a policy not to give a ruling on whether or not a deposit was non-bedded until the property was mined, or in production. Further opinion was expressed that, from the information furnished in the company brief, there was a distinct probability that operations would be considered a clay pit, and, therefore, would not qualify for the three year tax exemption.

Further inquiry to the Department of Mines and Technical Surveys provided information that rulings on non-bedded deposits were made on the basis of geological interpretation.

Missinaibi River Reconnaissance

A trip was made down the Missinaibi river by G. R. Guillet and D. E. Craig in mid-September, 1959, from Coal Creek to the mouth of the Opazatika river.

The purpose of the trip was to investigate the feasability of moving drilling equipment by water or tractor along the river banks, and familiarization with physical and geological conditions along the route where Cretaceous outcrops were known to exist.

The mouth of Coal Creek is in McBrien township about six miles down stream on the Missinaibi river from the Precambrian escarpment. The mouth of the Opazatika river is in Mahoney township about fifty miles from Coal Creek. The trip occupied ten days during which all the Cretaceous outcrops reported along the route in government publications were examined, including those up Coal Creek about one mile. Observations were made on water conditions, depth of overburden, suitable landing conditions for aircraft, the general characteristics of the clays and sands, and their structural features. A number of samples were obtained of materials representing the Cretaceous sediments.

The conclusions reached on the results of this trip were:

1. Shallow water conditions of late summer would prohibit movement of equipment by boat or barge.

2. The use of a tractor along the river banks would be impractical.

3. The servicing of camps by aircraft would be hampered by scarcity of landing places.

4. It was concluded that winter operations on the muskeg would provide greater flexibility of travel, more efficient servicing from the air, and permit a more uniform drilling coverage of the concession area.

Other observations made refer to the terrain and clay and sand outcrops more fully described elsewhere in this report.

EXPLORATION PROGRAM

The purpose of the exploration program was to find deposits of kaolin of sufficiently high quality and grade to bring into commercial production. In addition to the kaolin it was expected that silica sand and fireclays would be produced as by-products which would bear a proportion of the development and operating costs. In the search for these materials, the planning of the program had to take into consideration the following factors:

1. The large area of the concession - almost 504 square miles.

2. The widespread distribution of known Cretaceous deposits of clay and sand in the concession.

3. The muskeg conditions with resulting problems of transportation.

4. The variable though generally thick blanket of glacial till overlying the clays and sands of interest.

5. The characteristics of the Cretaceous deposits -- variations in composition and thickness of the clays and sands constituting the deposits.

With these points in mind and with the information available as the result of preliminary investigations, winter drilling was selected as the most suitable approach to the program.

Initial Planning

Although previous investigations by government geologists and others provided information on the clay and sand occurrences along the main rivers, nothing was known of their distribution or mode of occurrence within the interior of the concession. With little or nothing to act as a guide for the interior, systematic grid drilling appeared to offer the best possibilities for success. Drilling on four mile centres was proposed as a practicable spacing in view of the large area involved. However, it was decided to drill the first few holes at closer intervals in order to obtain a clearer picture of the geological distribution of the Cretaceous beds. The depth of the holes was to be 100 feet, as this was considered a maximum for economic operations. However, here again, the decision was made to drill the first few holes to greater depths if necessary to obtain more detailed information on the subsurface geology.

Geophysical methods were considered before the drilling got under way and at various times during the program. However, before they could be used it would be necessary to do some drilling to determine the characteristics and depths of the overburden and sediments. With experience gained in carrying out a program involving transportation in the concession as time passed, it was evident the use of geophysical methods, which would require a high degree of mobility, would prove very costly, and, the results might be of questionable value. The idea of using this approach was therefore abandoned.

Drilling Contract

The drilling contract was let to Joy Manufacturing Company of Galt, Ontario. The contract was drawn on the basis that the first month's drilling would be at cost plus rental of equipment. When conditions to be encountered became known, a contract would be established on an all-inclusive price per foot basis. Several attempts were made after the program got under way to arrive at a mutually satisfactory price, but as the result of field conditions encountered,

this did not prove possible. The problem centered mainly around the long moves between holes, together with the shallow depth of holes to be drilled. The uncertain winter conditions, location of routes and base camps unknown beforehand, and problems of crossing steep banked rivers, all presented hazards impossible to deal with in advance. The conclusions of 'Joy' were expressed in a letter of March 16, 1960, "The job environment does present many problems in moving the camp and supplying the operation, which would vary considerably over any given drilling program. For this reason, if we are forced to quote a price per foot, we would have to make the maximum provision for the problems and hazards encountered, which would not be entirely realistic". The drilling contract was carried on throughout the program on a cost and rental basis.

Drilling

The exploration work was conducted in two stages; a winter's drilling program, during which thirteen holes were drilled to depths of slightly over 200 feet, and summer auger drilling, during which twenty-five holes were drilled to depths of up to over fifty feet. The drilling was supplemented with geological reconnaissance to obtain additional information on distribution of Cretaceous outcrops and to determine favourable locations for drilling.

A. Winter Program

A preliminary trip was made early in November of 1959 by V. A. Haw, and J. Cooper, Contract Drilling Manager of Joy Manufacturing, to survey the general ground conditions for operations and to spot the first holes. Arrangements were made at the same time with the Spruce Falls Power and Paper Company for transportation of equipment and personnel over their private railroad to Smokey Falls from Kapuskasing. It was still possible at the time to drive by truck from Smokey Falls to the bottom of Long Rapids, where a campsite is located on the west bank of the Mattagami river. As this was the most accessible and convenient location from which to start the program, it was decided to establish the first camp here. As a group of patented claims owned by F. W. Warren of Dundas, Ontario, are located along the west bank of the river, it was necessary to start the drilling beyond them to the west. The first hole was spotted 200 feet west of the first claim boundary, which at this point is two claim lengths from the river. The location of this hole, along with those of all others, and the campsites, is shown on the concession map in the pocket of this report. This hole was located in thick spruce muskeg just off high ground to the east which stretched over to the river, and also, about one-quarter mile north

of the Precambrian escarpment. The muskeg stretches away to the north and west at this point; with tree growth becoming progressively thinner and more stunted until large areas of almost barren muskeg are reached.

Before returning from this preliminary trip permission to use cabins at the Long Rapids campsite was obtained from the owners in Smoky Falls. Plans were then proceeded with to move the drilling equipment and personnel into the concession for the beginning of the program. The crews moved into the area on November 25 and commenced drilling on December 2, 1960.

The major items of equipment included a 22HD core drill with a swivel hydraulic head, and two tractors with wide tracks. A full range of pipe, casing, and rods from six inch pipe to "B" rods with diamond and tricone bits, and soil sampling equipment were brought into the project in anticipation of a variety of drilling conditions. Crews were provided to maintain the drilling on a twenty-four hour basis.

Ventures' personnel on the job were occupied in spotting holes, logging core and samples, checking on the drilling performance, and preparation of maps and sections. G. R. Guillet and D. E. Craig shared these duties during the drill program under the general supervision of V. A. Haw.

The first few holes were started with six inch pipe as a collar, using a $5\frac{1}{2}$" tricone bit. As the hole descended, smaller diameter casing and bits were used down to 2 15/16". The last few holes drilled were started with NX casing, as they were to be limited to shallower depths. Heavy mud was used during this part of the program, although casing was used at the same time in most cases, in an attempt to prevent caving of the holes. The intention was to remove samples at ten foot intervals; however, the obtaining of proper samples proved to be very difficult, and so sampling at greater intervals was usually the case. Soil sampling techniques were used with both Shelby and split tubes.

Problems in drilling proved to be mainly penetration of the glacial till, which was extremely hard, and, of course, made more difficult by the contained cobbles and boulders, and also the continuous caving of the poorly consolidated Cretaceous silica sands. The latter were under hydraulic pressure and rose 25 feet or more up the hole on the withdrawal of the bit, in spite of the use of the barite loaded mud. The same two problems resulted in difficulties in obtaining samples. The till in most cases was very difficult to penetrate, using either the Shelby or split tubes. Caving of the hole, of course, made difficult the obtaining of representative samples. Results were that the taking of samples consumed a much larger proportion of time than was anticipated, and often, were only represented by a few cuttings from the tricone bit.

An account of the drilling operations and the results obtained is described below by townships in which the holes were located.

Kipling Township:

As explained above, although it was intended to ultimately use a four mile grid pattern to drill the concession, the first few holes were to be drilled at closer intervals to obtain additional geological information for use in interpretation of future drilling results. This was done in Kipling township, where seven holes were drilled in the west central part, as shown on the enclosed map.

The first hole drilled, MR 1, was started on December 2, 1959, and was stopped December 9, in Cretaceous fireclay at 221.5 feet. Details of each hole are shown on the accompanying sections. The first Cretaceous sediments were intersected at about 206 feet after passing through boulder till, and stoneless clays, interpreted as being of glacial lake origin. At 206 feet the first lenses of high purity silica sands were observed, and from 208 feet the hole passed through a horizon of silica sand with a low kaolin content. At 218 feet the hole entered a cream-grey fireclay mottled with reddish streaks and containing rusty eyes, and with a smooth, dense, plastic texture. The hole was stopped at 221.5 feet as considerable trouble had been encountered in keeping it open because of caving of the sand.

The second hole was located one-half mile north, and one-quarter mile to the west of the first. It was drilled to 65 feet through boulder till and then through 10 feet of impure sand when further drilling became impossible. Tricone bits had been used up until this point and diamond bits were tried. However, two bits were stripped of diamond without any further penetration, and so the hole was abandoned.

The next two holes, MR 3 and MR 4, were drilled at half-mile intervals due north of MR 2. Cretaceous silica sand was intersected at 100 feet in MR 3 and continued down to 200 feet before orange coloured fireclay was reached. Kaolin contents of the sand were obviously low throughout the hole, except between 114 and 120 feet, where the amount and colour looked promising. However, separation of the minus 10 micron fraction showed only 24 percent of it to be present. As in all cases when drilling the silica sand, caving of the hole up the casing under hydraulic pressure, and before obtaining representative samples with the Shelby tube, proved very troublesome. The hole was stopped at 201 feet. The fourth hole, MR 4, intersected the silica sands at 65 feet and continued on in it to 190 feet, where the hole was stopped. A thin bed of reddish fireclay was intersected at 132 feet. Kaolin contents of sand samples was generally low -- 5 to 6 percent, but at 95 and 144 feet samples ran between 20 and 24 percent minus 10 microns.

The next three holes, MR 5, 6 and 7 were stopped in

glacial materials — till, sand, or stoneless clay, at 100 feet. Reference to the accompanying maps will show that MR 5 extended the line of holes, MR 2-4, one-half mile to the north, and MR 6 and 7 were located in a north-south line two miles to the west. Drilling these holes to greater depths or at closer intervals could not be further justified because of the high costs experienced up to this point, when balanced against the information obtained. It was the middle of February before MR 7 was completed.

At this time the decision was made to start on the four mile grid system of drilling. Depths of holes were limited to 100 feet, as this was considered the maximum possible depth at which mining operations could be conducted.

Acres Township

With the start of drilling in Acres township the camp was moved over to the central part of the township from where four holes were drilled — MR 8-9-10-11. No serious problems were encountered in drilling these holes. With a definite limit of 100 feet placed on drilling depth, they were cellered with "NX" rather than six inch casing, and 2 15/16 in. tricone bits were used, which permitted faster drilling. With

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distances of up to 2 ½ miles between camp and the hole locations, together with deep snow and drifting in the open muskeg, transportation became the chief obstacle. Servicing of the project from outside now became entirely dependent on the use of aircraft.

The four holes were stopped in glacial till or clay. Marine clay was encountered for the first time in holes MR 10 and 11, the two on the west side of the township. It was observed to occur directly below the muskeg, which was two to four feet in thickness, and to continue down to depths of between 50 and 60 feet below the surface where it overlay glacial till or clay.

McCausland Township

The next camp was located in the central part of McCausland township from where holes MR 12 and 13 were drilled. MR 12 passed through muskeg and till, ending in glacial lake clay. MR 13 intersected muskeg, marine clay, and till, ending in glacial lake clay.

The last hole, MR 13, was completed April 4, 1960, when spring thawing conditions necessitated the withdrawal of equipment from the muskeg. Sunny skies predominated during the last few weeks of the program and the snow went quickly. As the muskeg was not frozen to any

appreciable depth, any delay in moving out heavy equipment might have been costly.

All samples obtained from the winter drilling were shipped to American Nepheline Limited at Nephton, Ontario. These were re-examined in May under more favourable circumstances to confirm findings in light of the winter's experience.

Summary and Conclusions on Winter Drilling Program

Thirteen bore holes were drilled during the period between December 2, 1959, and April 4, 1960. The results of the drilling are summarized in Table 1. Cretaceous sediments were intersected in holes MR 1, 3, and 4, at depths of 208, 95, and 65 feet respectively. The remaining ten holes were stopped in glacial till or clay of Pleistocene age. The results indicated that total thickness of overburden overlying the Cretaceous sediments in this part of the concession had a thickness of at least up to 208 feet, and generally greater than 100 feet. The finding of marine clay -- of post glacial age, in thicknesses of over 50 feet in the western part of Acres, and northern part of McCausland townships, is indicative of even greater thicknesses of overburden in these locations, and points to a basin-like structure with the eastern part of the concession on the slope dipping westward.

The Cretaceous sediments intersected consisted of thicknesses of well over 100 feet of kaolinitic silica sand as shown in holes MR 3 and 4. There is some indication of a Cretaceous dome with the high in the vicinity of MR 4. In contrast, work on the banks of the Mattagami river just below Long Rapids showed only about ten feet of silica sand overlying 45 feet or more of fireclay. MR 1 also showed a thickness of only ten feet of silica sand overlying the fireclay. Some of the silica sands in both MR 3 and 4 were associated with local concentrations of kaolin. However, the best samples ran only 24 percent or less minus 10 microns, and, of this only about 80 percent proved to be kaolin, as will be reported later in the section on laboratory results.

Work on the winter program was begun on November 25, 1959, apart from some preliminary work before that date, and lasted until about the middle of April, 1960, when personnel and equipment were finally returned to the south. During this period $35,980.85 had been spent on drilling alone, with a further $9,188.66 spent on company supervision. It was evident in view of the rather discouraging results that a program of this kind could not be further justified until evidence could be found of better grades of kaolin at shallower depths.

Table 1

Summary of Logs for Holes MR 1 - 13 Inclusive

Hole No.	Muskeg, Silt & Sand	Marine Clay	Glacial Till	Glacial Lake Clay	Cretaceous Sands	Cretaceous Fireclay
MR 1	0-15.0'		15.0'-82.0' 176.0'-208.0'	82.0'-176.0'	208.0'-218.3'	218.3'-221.5'
MR 2	0-13.0'		13.0'-72.0'			
MR 3	0-9.5'		9.5'-25.0' 50.0'-66.0'	25.0'-50.0' 66.0'-95.0'	95.0'-198.0'	198.0'-201.0'
MR 4	0-11.0'		11.0'-38.0' 51.0'-60.0'	38.0'-51.0' 60.0'-65.2'	65.2'-190.0'	thin bed at 132.0'
MR 5	0-7.0'		7.0'-29.0' 44.0'-59.0' 94.0'-100.0'	29.0'-44.0' 59.0'-94.0'		
MR 6	0-13.0'		30.0'-67.0' 83.0'-100.0'	13.0'-30.0' 67.0'-83.0'		
MR 7	0-12.0'		12.0'-37.0'	37.0'-100.0'		
MR 8	0-25.0'		89.0'-100.0'	25.0'-89.0'		
MR 9	0-2.0'		2.0'-50.0'	50.0'-100.0'		
MR 10	0-2.0'	2.0'-53.0'		53.0'-100.0'		
MR 11	0-4.0'	4.0'-58.0'		58.0'-100.0'		
MR 12	0-12.0'		12.0'-43.0'	43.0'-100.0'		
MR 13	0-8.0'	8.0'-74.0'	74.0'-90.0'	90.0'-100.0'		

2. Summer Program

A summer exploration program was initiated with the purpose of obtaining additional information on the Cretaceous deposits which would assist in determining a future course of action in continuing the project. In particular, it was considered necessary to find favourable evidence for the occurrence of kaolin of economic grades and quantity to justify further heavy expenditures as had been incurred during the previous winter.

To do this, a geological reconnaissance of the concession area was planned, to be supplemented by some hand augering of holes in creek beds. Some investigation into augering techniques suggested the possibility of using a power unit to obtain greater depths in drilling. The decision was finally made to spend up to two months on a summer auger drilling program during which holes of about 50 feet depth could be drilled at points of interest throughout the concession. By drilling along stream beds and river beds advantage could be taken of the natural erosion, thus eliminating appreciable thicknesses of overburden. This approach ultimately proved satisfactory in completing the exploration program. The depths of 50 feet or more which were reached in many of the auger holes were considered sufficient for the search of commercial deposits of kaolin or sand in this area.

A week's reconnaissance of the concession was made by aircraft in July by V. A. Haw and D. E. Craig. Information was obtained on summer field conditions in the muskeg, and the feasability of landing the aircraft in the small lakes of the concession and of using it for transportation in the drilling. Sites for base camps were selected and a number of holes were spotted after a brief survey of physiographic and geologic conditions had been made.

A party of five and equipment were flown from Remi Lake near Kapuskasing to Coal Creek on the Missinaibi River on August 10, 1960, to begin the summer drilling. The party consisted of V. A. Haw, G. R. Guillet, D. E. Craig, R. Kosy, and T. Davis.

The drilling equipment used on the project consisted of a 7½ h.p. McCulloch unit with a transmission and chuck, all of which weighed about 70 pounds. The auger flights were four feet in length and three inches in diameter, and were designed to fit one on to another to give a continuous flight of augers as the hole descends. The unit and augers are illustrated in photographs at the end of this section. The chief problem proved to be the extraction of the augers from the hole when it was required to remove samples and add additional lengths of auger. This was eventually overcome by the fitting of a small drum on the end of the chuck of the machine which enabled the auger flights to be hoisted with little difficulty.

A tentative program for the auger drilling was prepared for

the concession consisting of 38 holes. The holes were spotted on the basis of known geology, accessibility, and aerial coverage of the concession. A number were located along the Missinaibi River for the purpose of augmenting information on known Cretaceous deposits which had been drilled to depths of about 15 feet by hand auger. A number of other locations were selected adjacent to small lakes in the concession to permit the use of aircraft in transporting equipment and personnel. A few holes were located at points requiring portaging where it was considered important to obtain information in spite of the extra time required for their drilling.

The summer drilling is again described by the townships in which holes were located. The program started on the extreme west side of the concession in Burstall township.

Burstall Township

Four holes were drilled in Burstall township, located to explore the ground in close proximity to the Precambrian contact. Reference to the map will show the location of MRA 1-2-3-4, and, the change in direction of the Precambrian contact from east-west to a northerly direction. The hole MRA 1 is located on the bank of the Missinaibi River in Bell's Bay. It was drilled to 47 feet, through a mixed sand of recent fluvial origin. The sand consisted of limestone, quartz, feldspar, and dark coloured grains averaging 1/16 - 1/8 in. in size with a few constituents up to one inch. No further penetration beyond 47 feet was possible owing to a boulder or bed rock at the bottom of the hole.

The next hole MRA 2 was also drilled on the river bank close to a tongue of Precambrian outcrop. It was collared in red Cretaceous fireclay outcrop and was drilled through the same material to 40 feet, where recovery of the augers became almost impossible. The fireclay was found to be brick red, smooth, dense, very plastic, mottled with occasional thin cream coloured bands. The clay near the bottom of the hole was much drier, and in places crumbly in texture. A few segregations of kaolinitic silica sand were observed below 32 feet.

Holes MRA 3 and 4 were drilled on the shore of a small lake, and on the bank of a small creek respectively. However, their collar elevations were probably 100 feet or more higher than the two previous holes. MRA 3 was stopped at 27 feet * in hard boulder till, and MRA 4 in stoneless clay of marine or glacial origin at 48 feet. I type

* Foot note: Every effort was made to drill to 50 feet in all holes. However, the glacial tills proved very difficult to penetrate and holes were often stopped at shallower depths when drilling progress came almost to a standstill.

McBrien Township

Six holes were drilled in McBrien township, three up Coal Creek from the river, one inland in the central part of the township up a small stream valley, and two along the banks of the Missinaibi river in the eastern portion.

The first two holes MRA 5 and 6 were collared in silts about 10 feet above water level in Coal Creek. Both were drilled to about 50 feet and ended in glacial materials. MRA 5 was drilled about 100 yards up the creek from the river, and MRA 6 about 1/3 of a mile upstream, at a location where fireclays had been found previously (Montgomery and Watson). At the time of drilling no trace of the fireclays could be found in the vicinity of MRA 6 and the hole was collared at a location believed to be close to the previous discovery. However, the hole passed through nothing but till except for the top ten feet of silt and sand. Later, as the water level subsided, some dark clay was found in the bed of the creek about 200 feet from the location of MRA 6 which had the appearance and texture of fireclays found elsewhere, and similar to the material described by Montgomery and Watson.

The hole MRA 6A was located 1½ miles upstream on Coal Creek and was collared in a greenish-grey fireclay. The location is illustrated in picture no. 3, at the end of this section on summer drilling. The hole was drilled to 44½ feet where no further penetration was possible, because of either a boulder, or bed rock. The hole passed through variegated clays from top to bottom, exhibiting mainly pale blue-greys mottled with streaks and patches of buff, olive-greens, and brownish colours. From 42 to 44½ feet it was reddish brown in colour. Cherty fragments were abundant throughout most of the hole and are believed to come from thin cherty lenses interspersed in the fireclay. All the clay had the smooth, dense, and very plastic texture of Cretaceous fireclay.

Holes MRA 7 and 10 both ended in glacial till. The first was located about one mile up a small creek south of the Missinaibi river. It was stopped at 15 feet because of difficulties in penetrating a very hard, dense glacial till, in spite of several attempts at moving the location of the hole in the immediate area. The second hole, MRA 10 was located on the north bank of the river 1½ miles west of the mouth of the Pivabiska, and apart from the upper few feet of silt encountered nothing but till down to 47 feet.

Hole MRA 8 was located on the south bank of the Missinaibi river and collared 10 feet above the river in Cretaceous outcrop described by Crozier (6). At this location silica sands and fireclay were observed to occur at heights of about 60 feet above river level. After passing through one foot of mauve coloured fireclay the hole entered silica sand with a low kaolin content and continued through 56 feet of this material where it was stopped.

Garden Township

Two holes were drilled in Garden township near small lakes as shown on the concession map. The one, MRA 13, was drilled to 24 feet, and the other, MRA 17, to 32 feet, before they were stopped in glacial till because of difficulties of penetration.

Wright Township

Only the one hole was drilled owing to the inaccessibility of this part of the concession. It was located in the southwest corner of the township adjacent to a small lake on the west side. The hole passed through 40 feet of stoneless clay -- marine, or glacial lake, and was stopped at 48 feet in a fine glacial till. MRA 20

Amery Township

Four holes were drilled, MRA 11, 14, 15, and 19, three of which were located along the banks of the Missinaibi river, and one near a small lake on the south boundary of the township. All of them were stopped in glacial materials at depths of between 32 and 48 feet. The upper portions of MRA 14 and 19 may consist of marine clay down to about 15 feet, although identification was not positive.

Hambly Township

The two holes drilled in the township were located at the ends of two narrow lakes in line running northwest-southeast. The northwest hole, MRA 23, was stopped at 26 feet in heavy boulder till with marine clay between 6 and 20 feet. The southeast hole got to 48 feet and was stopped in stoneless clay. Considerable thicknesses of sand and gravel were intersected intermittently in MRA 23 between the collar and 40 feet. Clay material in parts of this sequence may be of marine origin.

Habel Township

Two holes were drilled, MRA 26 and 26A, in the township near the mouth of the Little Soweska river at the Missinaibi. The holes were drilled into Cretaceous silica sands outcrops described by Crozier. The sands occur 25 feet above water level at this location. MRA 26 was located 300 feet up the Little Soweska from the Missinaibi river and MRA 26A on the north bank of the Missinaibi 50 feet above the mouth of the Little Soweska. Both holes were very similar in composition. Except for the upper

two to eight feet which consisted of silt, they intersected silica sands with low to medium (5 to about 15%) kaolin contents throughout their length to 48 feet. In MRA 26 a bed about one foot thick of white plastic clay was intersected at 39 feet. The upper 10 feet of silica sands were stained a rusty colour to various degrees. Otherwise the sand is fine to medium grained, sub-angular and white, consisting essentially of all quartz.

Mahoney Township

The two holes drilled in the township were located on the banks of the Missinaibi river in the west central, and eastern parts. The one, MRA 29 reached 48 feet in stoneless clay (glacial lake) and the other, MRA 31, got to 40 feet and was stopped in a mixture of sand and clay.

Kipling Township

The last two holes drilled were located in Kipling township on the east bank of the Mattagami river downstream and across from the previous winter's drilling. The south hole, MRA 34, was collared in a silt fifteen feet above the river and penetrated through nearly twenty feet of dark stoneless clays of probable recent origin -- marine and swamp clay. After passing through fifteen feet of till it entered a sand composed of quartz, feldspar, mica, and limestone, and was stopped at 48 feet. The north hole, MRA 35, was located less than a half mile south of the north boundary of Kipling township. Its location is probably just south about one quarter mile from shafts and drill holes described by Montgomery and Watson, (5), in which dark coloured fireclays were reported to have been discovered. The material intersected in MRA 35 did not have the characteristics of previously described fireclays. It contained fine grained mica giving it a very greasy feel, and granitic and limestone inclusions, although not in sufficient number to identify it as a till. It is simply described here as a stoneless clay without any generic designation.

In addition to the company drilling, information was received from the Hydro-Electric Power Commission of Ontario through the courtesy of Mr. O. E. Johnston, Hydraulic Generation Engineer, on some shallow drilling completed along Adams Creek near the eastern boundary of Kipling township. A number of holes were drilled in a north-south direction down over the Precambrian escarpment and north to the Mattagami river. The holes were drilled to only about 30 feet and penetrated no deeper than the glacial till. No evidence was found of Cretaceous sediments in any of these holes.

Summary of Summer Drilling Program

Twenty-five holes were drilled by power auger during the summer exploration program which lasted from August 10, 1960, to September 26th. Most of these holes were drilled to depths of close to 50 feet, although a few were stopped at shallower depths because of slow progress in penetrating very hard dense till. The results of drilling are summarized in Table 2, and details of each hole are illustrated in the accompanying sections. Cretaceous sediments were intersected in only five holes and in each case the holes were collared in Cretaceous outcrops, or very close by, which were previously known. These are located in Burstall, McBrien, and Habel townships at hole locations MRA 2-6A-8-26-26A. The first two were in fireclay continuously to the bottom of the holes at 40½ and 44½ feet. The remaining three were in silica sand almost from the collar to the bottom at 56, 46, and 48 feet. The kaolin contents of the sands were all estimated to be below fifteen percent as a maximum, and for the most part less that five percent.

Little information was obtained on the depth of overburden overlying the Cretaceous surface during the auger drilling. However, it was established that overburden depth exceeded fifty feet in a number of widely distributed locations in the concession, and, considering the holes drilled in the eroded valleys of streams and rivers, total depth of overburden is in excess of 200 or more feet at these locations.

The summer program was terminated on the 26th of September, due to unfavourable weather conditions. About seventy-five percent of the program originally planned was completed and all townships had received some attention.

Table 2

Summary of Logs for MRA Series of Holes

Hole No.	Muskeg & Silt & Sand	Marine Clay	Glacial Till	Glacial Lake Clay	Cretaceous Sand	Cretaceous Fireclay
MRA 1	0-47'					0-40'
2						
3	0-2'		2'-27'			
4	0-3'		3'-11'	11'-48'		
5	0-12'		12'-39'	39'-50'		
6	0-12'		12'-48'			
6A						0-44½'
7	0-5'		5'-15'			
8					1'-56'	0-1'
10	0-11'		11'-47'			
11	0-12'		12'-48'			
13	0-14'		14'-24'			
14	0-2'	2'-12'		12'-48'		
15	0-18'		18'-36'			
17	0-8'		8'-32'			
19	0-1'	1'-16'?		16'-32'?		
20	0-2'	?	42'-48'	2'-42'?		
23		0-22'	22'-26'			
24	0-34'			34'-48'		
26	0-2'				2'-48'	
26A	0-8'				8'-48'	
29	0-2'		2'-8'	8'-48'		
31	0-12'			12'-40'		
34	0-6'		20'-36'	6'-20'		
				36'-48'		
35				0-44' - maybe partly Cretaceous		

GEOLOGY

On the basis of the drilling completed during the course of this project, and examination of river banks up to 200 feet high, it is evident that the whole concession is overlain by a thick mantle of glacial till and clay except where rivers and streams, by erosion, have exposed Cretaceous outcrops. An examination of the drill hole sections also shows that thicknesses of Marine Clay of Recent Age of up to at least 66 feet occupy portions of the central part of the concession, and these rest on Pleistocene glacial materials. This indicates a topographic depression in this area of the concession in the post glacial surface. This is suggestive of the basin-like structure proposed by Dyer for this area.

The main target of the drilling was the Cretaceous horizons in which it was hoped to find kaolin of commercial grades. The early part of the winter drilling was intended to establish geological information which would serve as a guide in subsequent planning of the exploration program. This proved unsuccessful, partly because of the high costs incurred in drilling through the deep overburden, but also due to the irregular and unpredictable depths at which the Cretaceous was intersected. Examination of Cretaceous exposures and drilling in the western part of the concession also showed that marked variations in depth of the top of the Cretaceous could be expected within limited horizontal distances -- in one instance a hole 50 feet deep failed to intersect fireclay that was exposed in a creek bed 200 feet away.

It appears evident, and logical, that the original upper Cretaceous land surface was greatly modified by glacial action. During the movement of the glacier over the Cretaceous surface differential erosion occurred, reflecting variations in abrading action of the debris carried by the glacier. The result was a highly irregular glaciated Cretaceous surface characterized by ridges and valleys wholly unpredictable in extent and distribution.

An abbreviated account of the drilling has been given in previous sections.. Further descriptive detail follows on the composition and occurrence of each of the sedimentary materials intersected in the course of the drilling.

Description of Sedimentary Materials

RECENT

1. Muskeg

Roots, humus, soil, and other organic materials. In depth it was found to vary between two and ten feet from surface.

2. Silts, Sand, and Gravel

Fine yellow silt underlay the muskeg for depths of 10'-15' in many of the holes back from the streams. Layers of coarser sand and gravel were also sometimes found to be present. Holes located on stream banks commonly passed through a few feet of dark brown silt before entering underlying clays and tills.

3. Marine Clay

Where identified the marine clay was observed to be dark grey, structureless, plastic, smooth, and highly calcareous; diagnostic features -- presence of white shells and absence of fine bedding, or varves. Hair-like, twig, and bark inclusions common, with occasional pebbles of granite or limestone. Greatest depth of marine clay observed was in hole MR 13 at 66+ feet.

PLEISTOCENE

4. Glacial Till

The tills were found to be highly variable in composition and appearance. The matrix is uniformly dense, and calcareous, although varying between silty and non-plastic to clayey and highly plastic in texture. When moist it is dark grey to olive grey in colour. Most of the constituents are limestone, although up to about 25 percent are granitic and quartz. A large proportion of the till drilled contained mainly constituents of sand size range, with some containing cobbles up to three inches. In the majority of holes drilled the glacial till underlay the marine clay, silt, or muskeg of Recent age. Layers of till were separated by stoneless clays and sandy clays in a number of holes, indicating more than one period of advance and retreat of the glacier. It is a reasonable supposition that had all the holes been drilled to 100 feet or more the same situation would have been encountered. The greatest depth at which till was found occurred in hole MR 1 at 206 feet.

5. Stoneless Clays

Most of the stoneless clays encountered in the drilling were undoubtedly of fresh water -- glacial lake origin. When positively identified the typical varves of light and dark coloured beds were exhibited. They were generally plastic, smooth, and calcareous. A wide variety of constituents were found present -- bark, roots, plant stems, hair-like inclusions, and peaty or carbonaceous material. Some of the stoneless clays, however, were very dark, but mottled in colour, and contained abundant inclusions of plant growth. These may represent inter-glacial clays deposited in a more temperate climate than those associated with glacial conditions.

It was not always possible to delineate between the stoneless clays of glacial lake origin and those deposited in salt water (marine clays), particularly in the auger holes where undisturbed samples were impossible to obtain. Finally, some of the so-called stoneless clays as designated in the drill logs and sections are decidedly sandy in composition, containing thin lenses or beds of almost pure sand of heterogenious composition. These were found more commonly in the upper horizons.

CRETACEOUS

Silica Sand

The silica sand is composed of essentially all quartz grains of a size range mainly between 10 and 100 mesh. The grains are clear in colour and sub-angular in shape. In the upper portions of the beds some impurities were found in the form of feldspar, limestone, and dark coloured constituents. Where the beds occur near the surface some brown staining is evident as the result of oxidation. Associated with the sand grains is kaolin in amounts usually less than 10 percent; a few samples contained as much as 15-20 percent. The kaolin is white in colour and readily washed free from the quartz. It was found to occur in thicknesses of up to 125 feet below the overlying glacial till. The silica sand beds formed the upper portion of the Cretaceous stratigraphic sequence of most of the occurrences investigated.

Fireclays

These exhibit a variety of colours, and are mottled and streaked by hues of red, green, pale greys, white, brown and black. They are highly plastic, very smooth, and dense. At depth where they are drier, they are crumbly. In one location they were found associated with abundant chert. Thicknesses of fireclay of between 40 and 45 feet were

encountered in the western part of the concession. General Refractory Products reported thicknesses of fireclay of the same order along the banks of the Mattagami river on the eastern side. Except for a few very thin beds it was found underlying the silica sand where the latter occurred.

LABORATORY INVESTIGATIONS

Samples from the drilling were evaluated in laboratories of American Nepheline Limited, Lakefield Research Limited, and the Mines Branch at Ottawa. The objects of this work were to determine a method of separating the kaolin from the sand, and the investigation of the physical and chemical properties of the separated products.

The kaolin-sand separations were first studied on a laboratory scale in order to develop a method for establishing the kaolin content of small bore hole samples. A technique involving sedimentation was evolved whereby the sample is dispersed in a solution of sodium carbonate and sodium metaphosphate and thoroughly agitated followed by settling periods of different lengths of time, depending on the size of separation required. The size of the settled constituents was calculated on the basis of Stoke's law and checked with a Bouyoucas hydrometer.

The determinations were made on the clay for composition, using chemical and differential thermal analyses, and, ceramic properties. Determinations on the sand were made for chemical composition and grading. The results of this work are tabulated as follows:

Table 3

Clay-Sand Separations and Clay Composition

Sample No.	Hole Footage	% -10 Micron	Kaolinite * Content	Quartz * Content
MR 4-4954	208.0'	5.7		
22	209.0'	4.4		
23	210.3'	2.2		
24	211.7'	3.1		
25	213.3'	1.4		
MR 4-4957	118.0'	6.3		
38	120.0'	24.6		
48	151.0'	12.8	70	15
MR 4-4955	65.5'	11.7		
56	67.0'	14.6	85	11
MR 4-4957	68.5'	6.0		
58	71.5'	5.8		
60	95.0'	20.6	81	6
65	144.0'	22.2	77	8
66	166.0'	6.4		
Composite MR 4		7.8	60	2

* By differential thermal analysis of the -10 micron fractions

Several samples were separated at five microns, and compositions of the fractions determined:

Table 4

Clay-Sand Separations, and Compositions Separated at 5 Microns

	% -5 Micron	Kaolinite Content %	Quartz Content %
MR 4 Comp. Water Washed	7.1	75	2
MR 4 Comp. Acid Washed	7.1	60	1
MR 4-4965	17.2	67	1

Composite samples of the clay from No. MR 4 were fired to determine some ceramic properties:

	PCE	Color
HR 4 comp. -- 5 microns	33-34	tan
HR 4 comp. -- 10 microns	33	tan

Samples of -- 5 micron clay were water and acid washed separately and then chemically analyzed:

	Water Washed	Acid Washed *
Fe_2O_3	1.64	1.43
Al_2O_3	36.07	35.54
CaO	0.36	0.17
LOI 500°C	13.68	12.93
LOI 900°C	14.81	13.82

* In 20% HCL for 30 minutes

Samples of kaolinitic sands were obtained from exposures along the Mississaibi river bank, which were graded and analyzed for iron:

Table 5

Sieve Analysis

Screen No.	#3 Sample	#4	#5	#7	#8	#9
		Cumulative % Retained				
10	0.1	14.5	0.1	1.2	1.0	4.2
20	1.3	63.0	4.1	16.3	17.1	29.6
35	10.6	85.1	26.6	51.1	79.9	72.6
48	39.2	89.0	56.5	73.9	83.4	81.7
65	66.4	90.6	79.9	86.1	91.2	84.5
100	87.3	93.9	90.7	91.6	95.9	87.7
% Fe_2O_3	0.091	0.066	0.196	0.088	0.33	0.22

The above samples when screened on 100 mesh with the undersize discarded were reduced to .05% Fe_2O_3 or less.

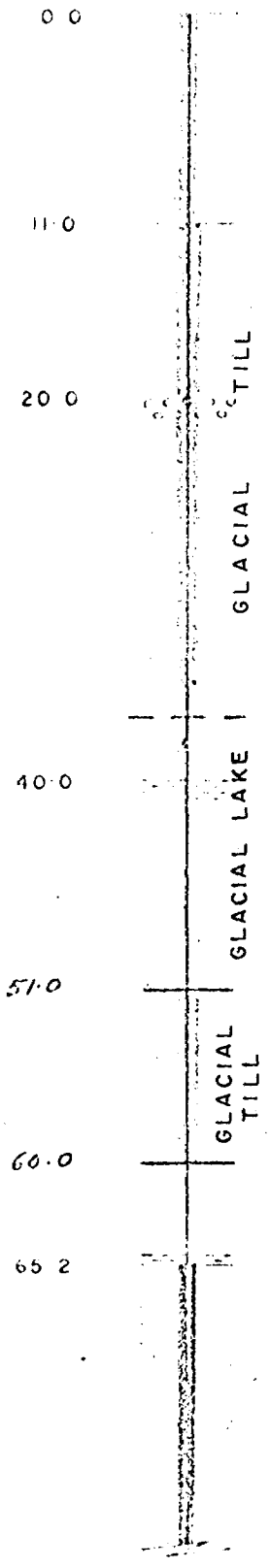
MOOSE RIVER KAOLIN

BORE HOLE MR 4

KIPLING TOWNSHIP

26,240' NORTH
10,270' EAST
ELEV

1" = 10'



0 0 — COLLAR

MUSKEG

RECENT / PLEISTOCENE

11·0

20 0 — ABUNDANT COARSE GRAVEL

40·0 — THIN RIPPLY LAMINATIONS, SILTY TO SANDY

51·0 — OCCASIONAL BOULDERS AND HARDPAN

60·0

65 2

PLEISTOCENE / CRETACEOUS

99% QUARTZ, FINE TO MED GRAINED, MEDIUM CONTENT OF WHITE CLAY

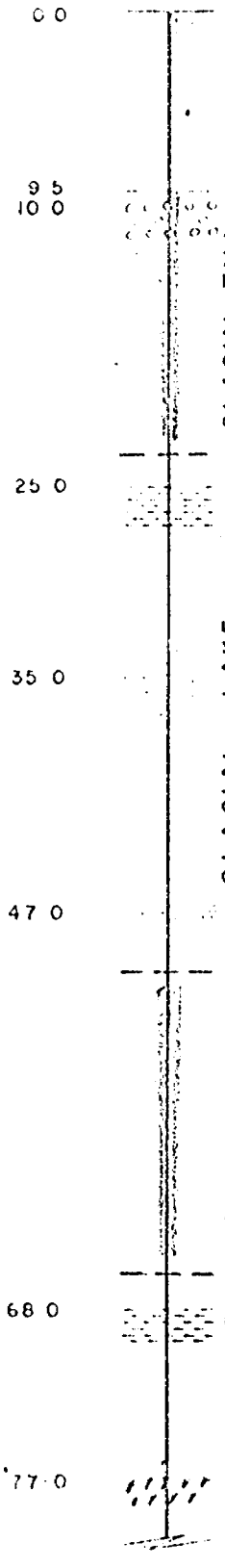
MOOSE RIVER KAOLIN

BORE HOLE MR 3

KIPLING TOWNSHIP

23,600' NORTH
10,270' EAST
ELEV

1" = 10'



COLLAR

MUSKEG

RECENT
PLEISTOCENE

INCLUSIONS MOSTLY PEBBLES

THINLY LAMINATED, SILTY TO SANDY

LOW CLAY CONTENT

50 % QUARTZ

MODERATE NUMBER OF BOULDERS

VARVED

BLACK CARBONACEOUS, WITH INCLUSIONS OF LIGHT-COLOURED CLAY AND HAIR-LIKE ROOTS

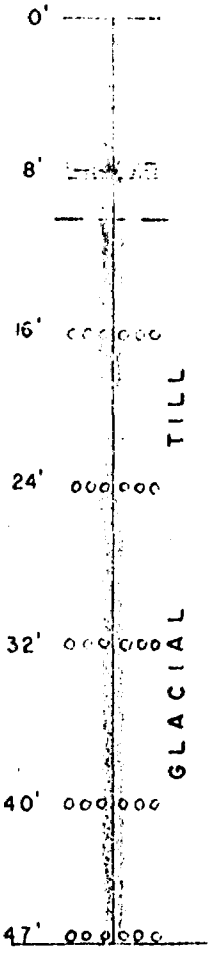
MOOSE RIVER KAOLIN

AUGER HOLE MRA-10

McBRIEN TOWNSHIP

7.5 MILES NORTH
8.1 MILES EAST
ELEV.-

1" = 10'



COLLAR

RIVER SILT

RECENT
PLEISTOCENE

MED. GRAY SCARCE LIMESTONE INCLUSIONS

ABUNDANT INCLUSIONS TO 1"

AS ABOVE

END OF HOLE

MOOSE RIVER KAOLIN

AUGER HOLE MRA-II

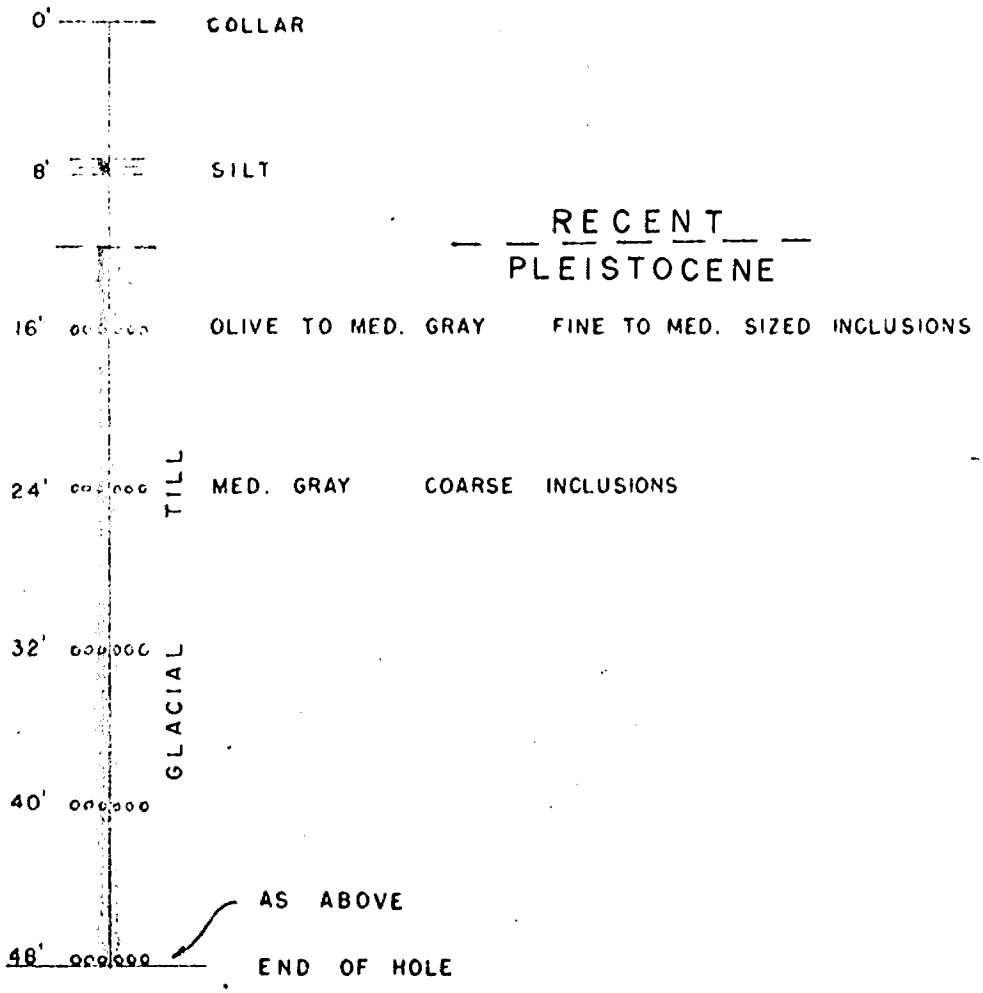
AMERY TOWNSHIP

0.8 MILES NORTH

1.0 MILE EAST

ELEV. -

1" = 10'



MOOSE RIVER KAOLIN

AUGER HOLE MRA-13

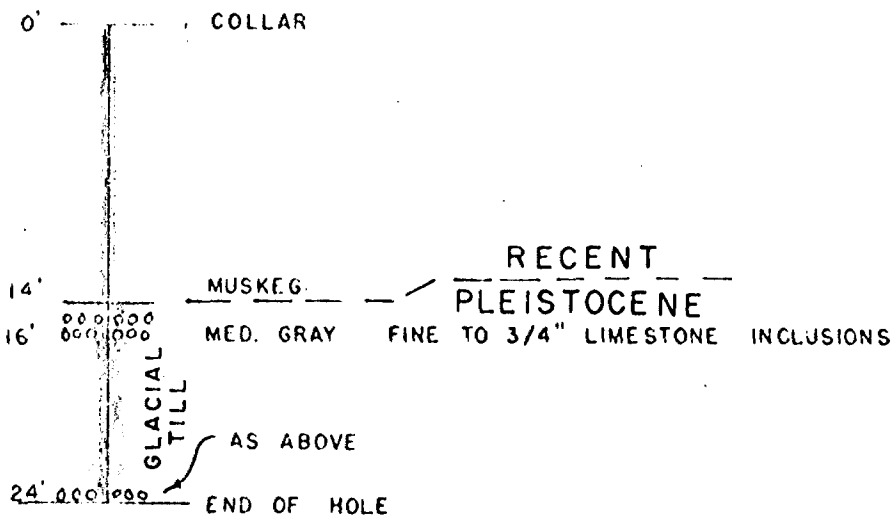
GARDEN TOWNSHIP

3.3 MILES NORTH

2.8 MILES EAST

ELEV. –

1" = 10'



MOOSE RIVER KAOLIN

AUGER HOLE MRA-14

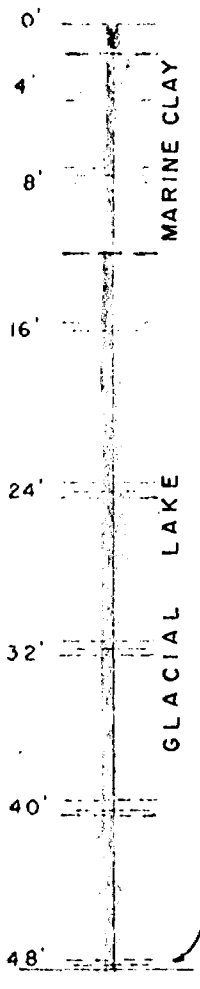
AMERY TOWNSHIP

.25 MILES NORTH

3.2 MILES EAST

ELEV.-

1" = 10'



COLLAR

MOSS & DRY SANDY SILT

BUFF TO BROWN SILTY

MED. GRAY (MARINE ?)

RECENT

PLEISTOCENE

SCARCE INCLUSIONS FINE TO COARSE

AS ABOVE

END OF HOLE

MOOSE RIVER KAOLIN

AUGER HOLE MRA-15

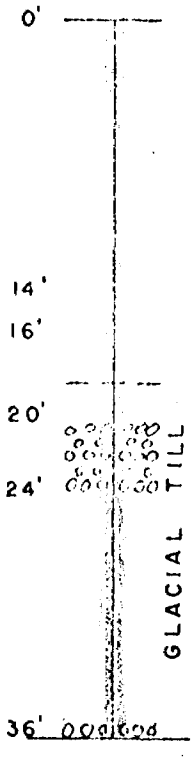
AMERY TOWNSHIP

2.8 MILES NORTH

4.2 MILES EAST

ELEV. –

1" = 10'



RECENT

PLEISTOCENE

MOOSE RIVER KAOLIN

AUGER HOLE MRA-17

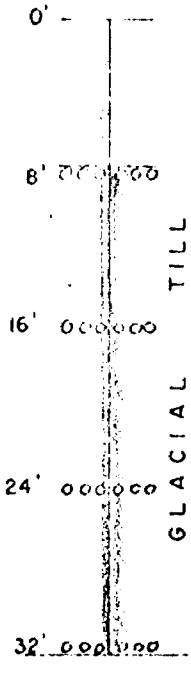
GARDEN TOWNSHIP

7.6 MILES NORTH

6.7 MILES EAST

ELEV.—

1" = 10'



COLLAR

BEACH SAND

BROWN TO BUFF SCARCE INCLUSIONS

RECENT

PLEISTOCENE

MED. GRAY

AS ABOVE

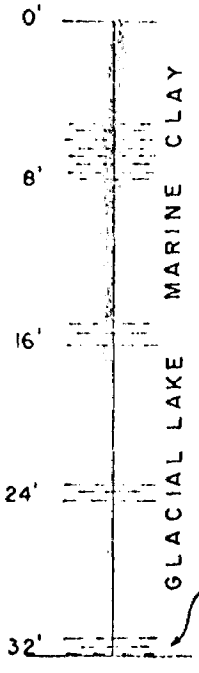
END OF HOLE

MOOSE RIVER KAOLIN

AUGER HOLE MRA-19

AMERY TOWNSHIP
4.8 MILES NORTH
7.6 MILES EAST
ELEV. —

1" = 10'



0' — COLLAR

8' — STONELESS CLAY SCARCE INCLUSIONS TO 1/2"

RECENT
PLEISTOCENE

AS ABOVE

32' — END OF HOLE

MOOSE RIVER KAOLIN

AUGER HOLE MRA-23

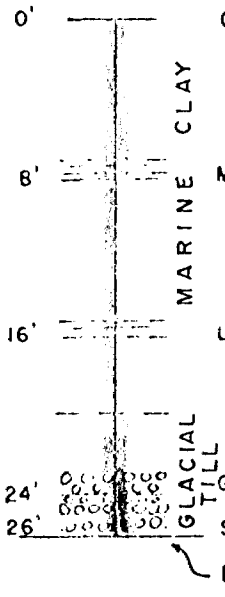
HAMBLY TOWNSHIP

4.9 MILES NORTH

3.4 MILES EAST

ELEV.—

1" = 10'



0' COLLAR

8' MARINE BLUISH GRAY SMALL WHITE SHELLS

16' LESS SHELLS SCARCE LIMESTONE COARSE SIZE

24' GRAY TO BUFF INCLUSIONS FINE TO 3/4"

26' SANDY

END OF HOLE

RECENT

PLEISTOCENE

MOOSE RIVER KAOLIN

AUGER HOLE MRA-26A

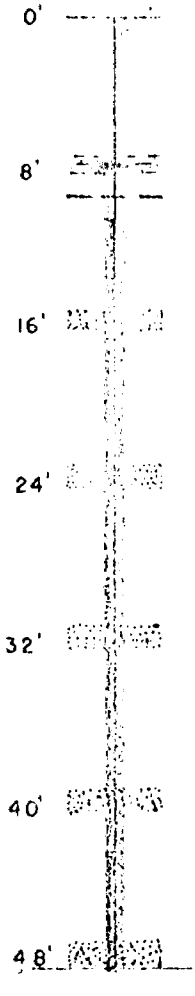
HABEL TOWNSHIP

1·6 MILES NORTH

3·6 MILES EAST

ELEV.—

1" = 10'



0' COLLAR

8' RIVER SILT

RECENT

CRETACEOUS

16' GRAY, COARSE GRAINED, LOW KAOLIN

24' AS ABOVE

32' WHITE, MED. GRAINED

40' AS ABOVE

48' SOME LIMESTONE PEBBLES TO 1"

END OF HOLE

MOOSE RIVER KAOLIN

AUGER HOLE MRA-29

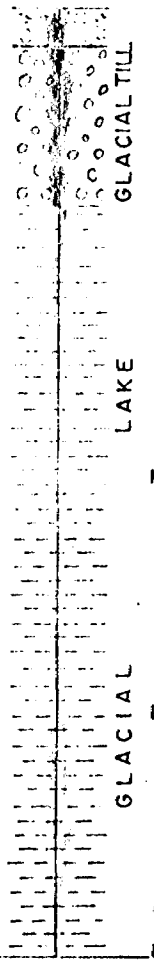
MAHONEY TOWNSHIP

3·1 MILES NORTH

3·0 MILES EAST

ELEV.—

1" = 10'



0' COLLAR

2' SAND & GRAVEL — RECENT / PLEISTOCENE

MED. GRAY INCLUSIONS TO 1/2"

8'

16' MED. GRAY WITH YELLOWISH BANDS, DENSE, PLASTIC

24' MED. GRAY STREAKED DARK GRAY

36' LIGHT GRAY, FINE SAND INCLUSIONS

AS ABOVE

48' END OF HOLE

MOOSE RIVER KAOLIN

AUGER HOLE MRA-31

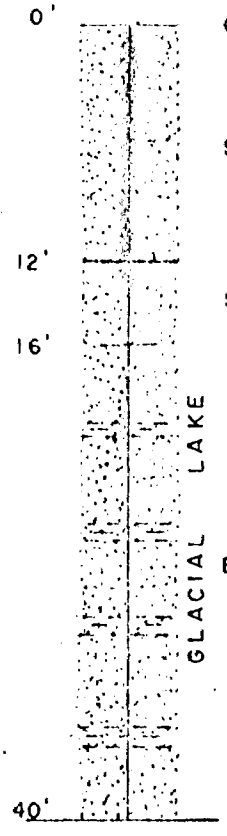
MAHONEY TOWNSHIP

5.6 MILES NORTH

7.7 MILES EAST

ELEV.—

1" = 10'



COLLAR

SILT

RECENT

PLEISTOCENE

SAND (FINE GRANITIC & LIMESTONE)

BEDDED SAND & CLAY

MOOSE RIVER KAOLIN

AUGER HOLE MRA-34

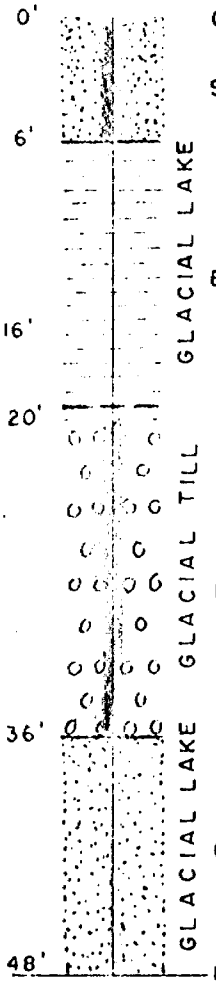
KIPLING TOWNSHIP

6.1 MILES NORTH

4.0 MILES EAST

ELEV. —

1" = 10'



COLLAR

SILT

RECENT

PLEISTOCENE

River Level

BLUE GRAY, DENSE PLASTIC

MED. GRAY INCLUSIONS TO 1"

GRANITIC & LIMESTONE MED. GRAINED

END OF HOLE

MOOSE RIVER KAOLIN

AUGER HOLE MRA-35

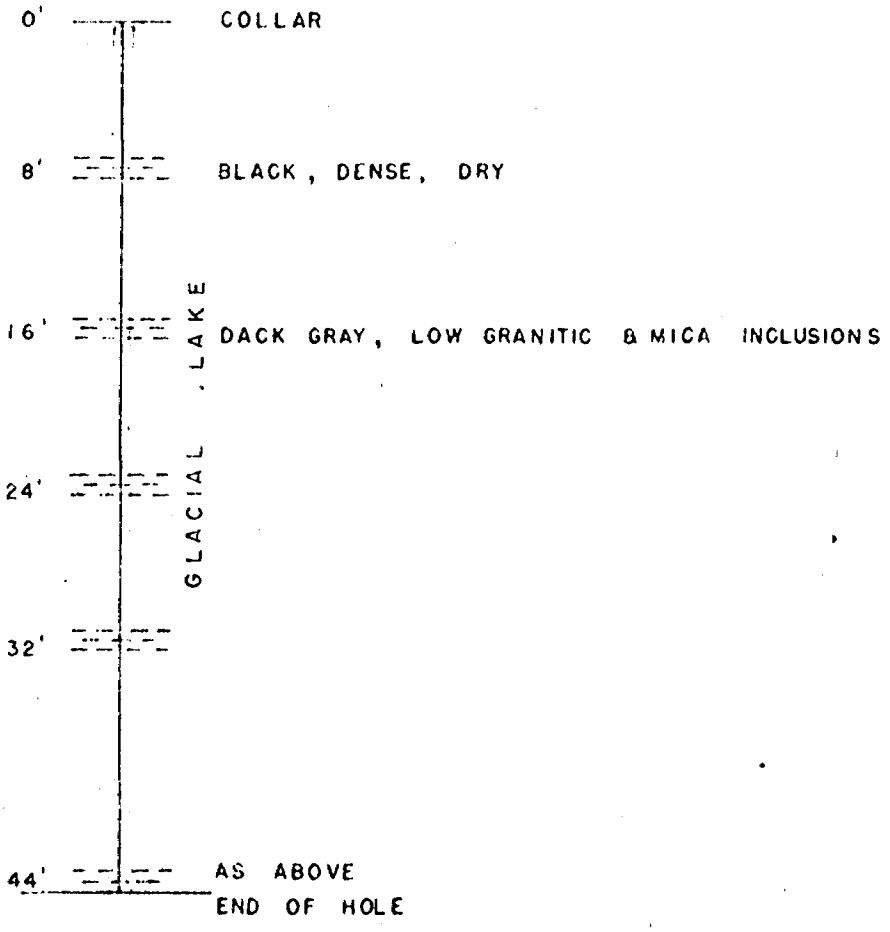
KIPLING TOWNSHIP

8 6 MILES NORTH

5.7 MILES EAST

ELEV.—

1" = 10'



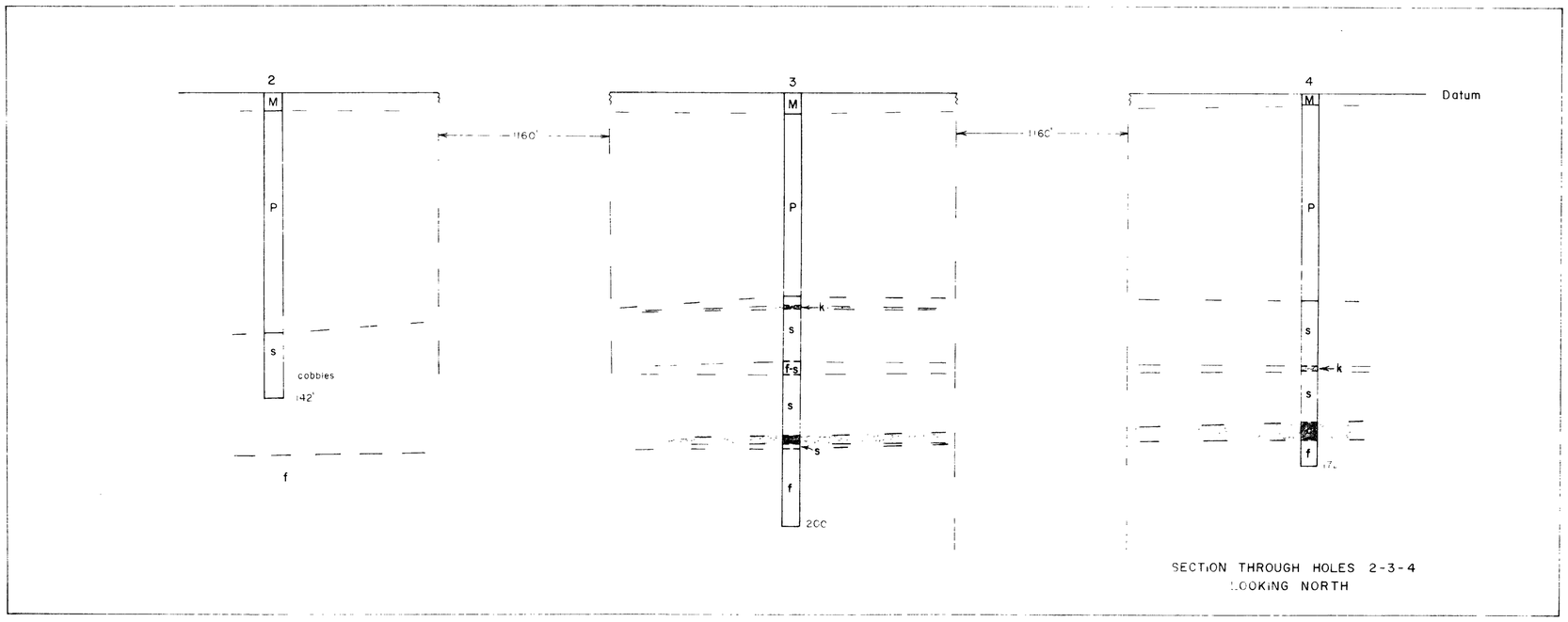
ALL PLEISTOCENE

FIGURE 4

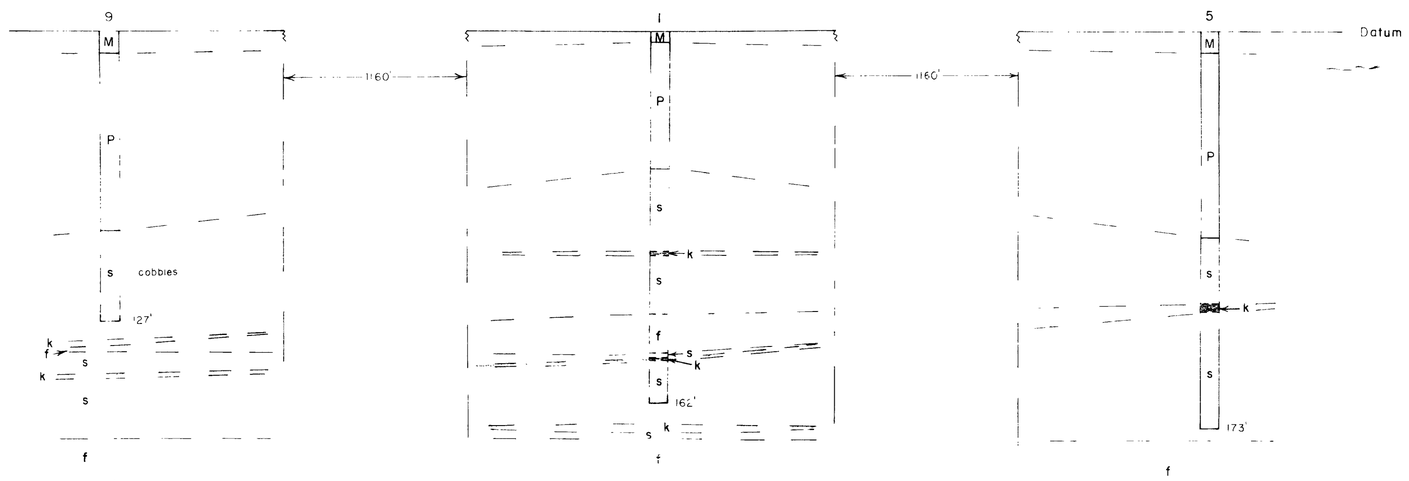
SECTIONS THROUGH HOLES 2-3-4, 9-1-5, & 8-7-6 LOOKING NORTH

SCALE: 1" = 40'

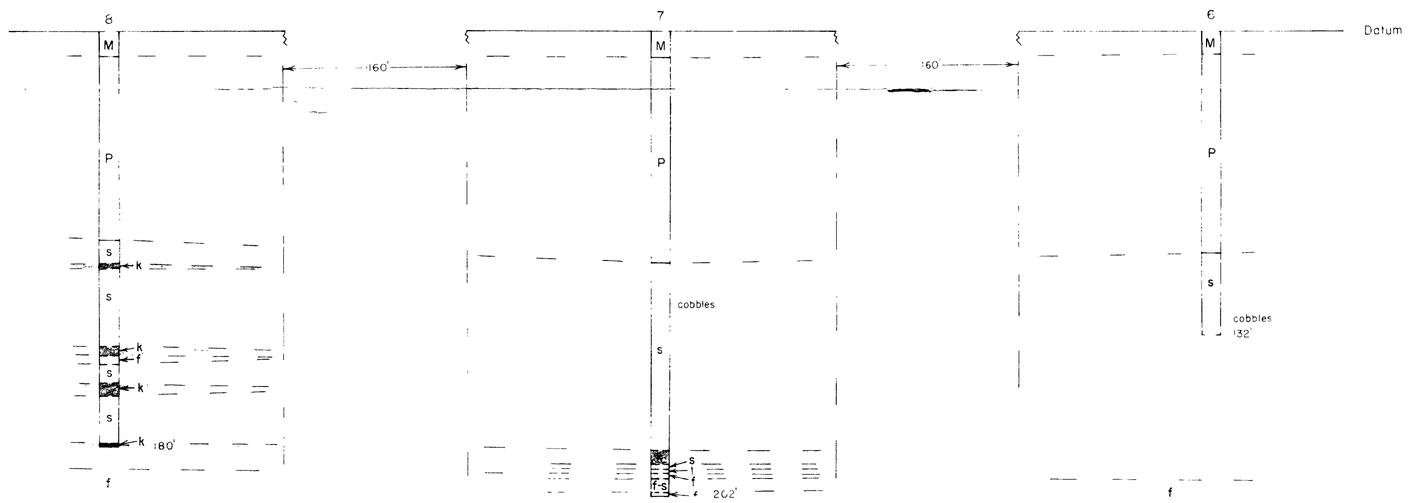
Datum is elevation of collar of Hole 1



SECTION THROUGH HOLES 2-3-4
LOOKING NORTH



SECTION THROUGH HOLES 9-1-5
LOOKING NORTH



Notes 1. Hole 7 is shown as a composite of the holes drilled at this site See log for details
2. Hole 7 is projected 30° south to plane of section

SECTION THROUGH HOLES 8-7-6
LOOKING NORTH

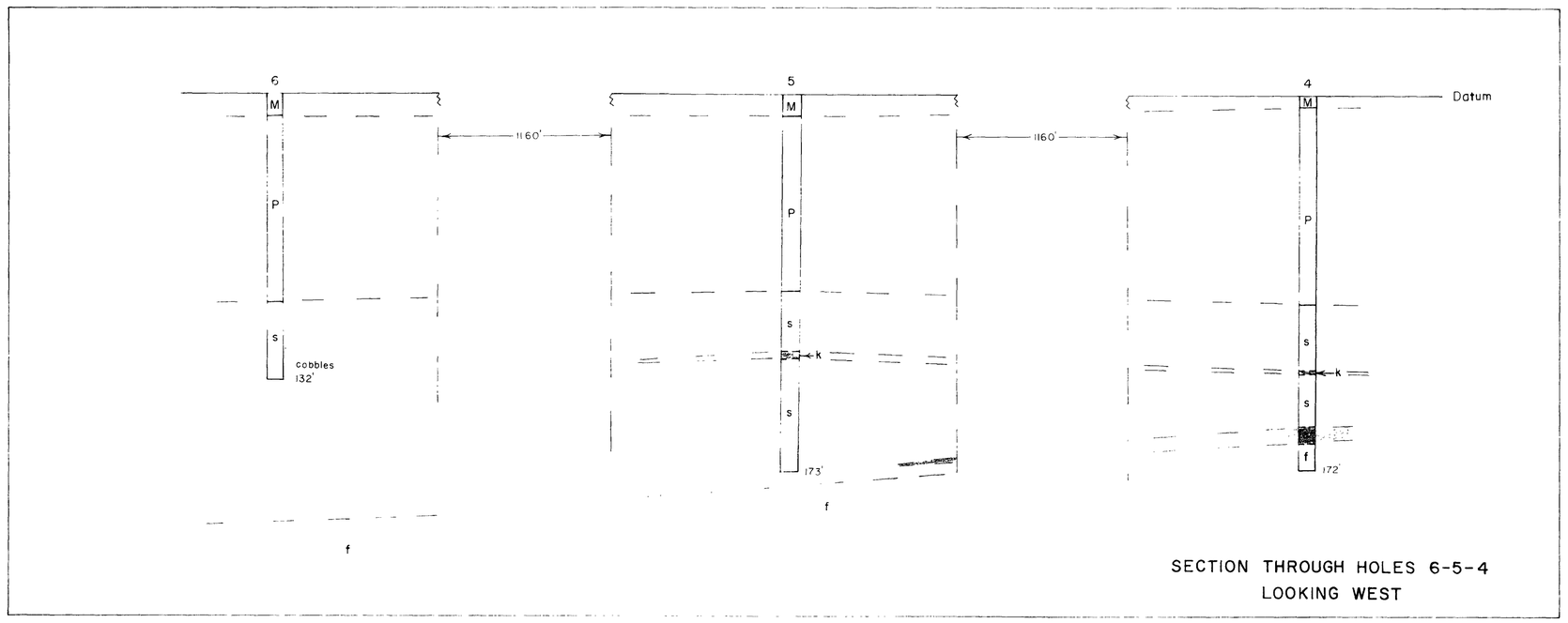
LEGEND

M	RECENT	muskeg
P	PLEISTOCENE	clay, silt, sand, gravel, till Not differentiated on sections, for details see logs.

CRETACEOUS

s	
k	kaolin-rich section of kaolinitic silica sand
f	fireclay
f-s	interbedded fireclay and silica sand
c	clay other than fireclay
l	lignite

83.1-77



SECTION THROUGH HOLES 6-5-4
LOOKING WEST

FIGURE 5

SECTIONS THROUGH HOLES 6-5-4, 7-1-3, & 8-9-2 LOOKING WEST

SCALE 1" = 40'

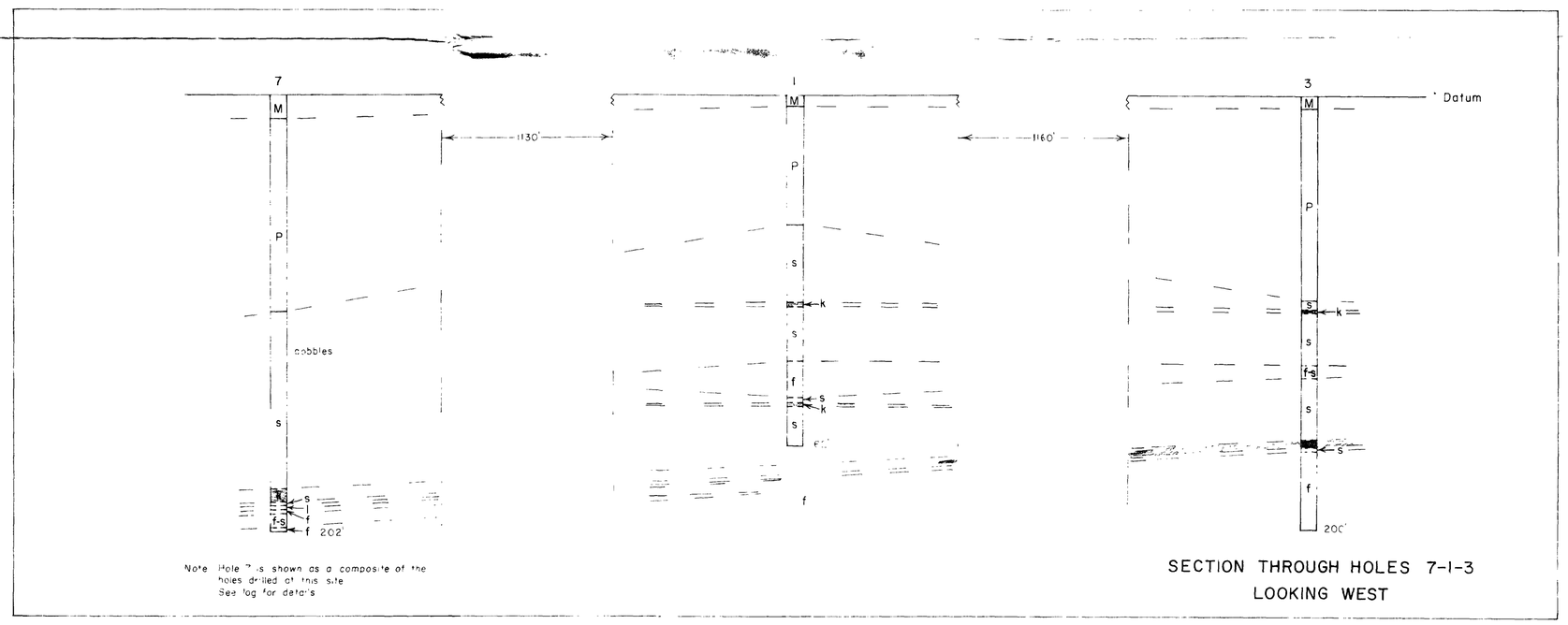
Datum is elevation of collar of Hole 1

LEGEND

- M — RECENT: muskeg
- P — PLEISTOCENE: clay, silt, sand, gravel, till. Not differentiated on sections, for details see logs.

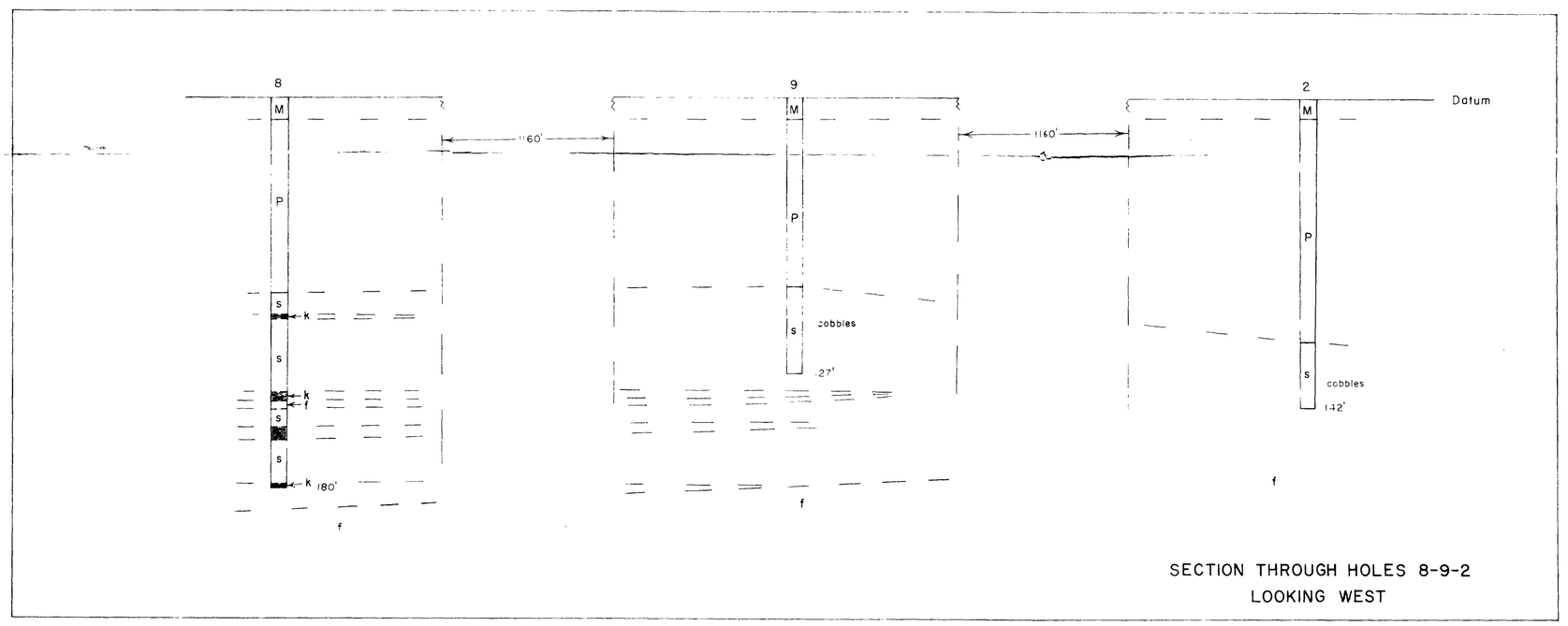
CRETACEOUS

- s — kaolinitic silica sand
- k — kaolin-rich section of kaolinitic silica sand
- f — fireclay.
- f-s — interbedded fireclay and silica sand
- kC — clay other than fireclay
- l — lignite



Note Hole 7 is shown as a composite of the holes drilled at this site See log for details

SECTION THROUGH HOLES 7-1-3
LOOKING WEST



SECTION THROUGH HOLES 8-9-2
LOOKING WEST