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SUMMARY REPORT ON THE 1982 EXPLORATION PROGRAM IN THE JAMES BAY LOWLAND FOR ONEXCO MINERALS LTD.
VOLUME I

R. J. Griffis
J. M. Stratman
S. A. Young
Watts, Griffis and McOuat Limited
Consulting Geologists and Engineers

Toronto, Canada
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1. EXECUTIVE SUMMARY

The 1982 exploration program centred around a helicopter-supported drill program. A total of 18 holes were drilled using a combination of reverse-circulation and triple-tube coring. The Acker P-38 drill, adapted for a helicopter-supported program, performed very well, as did the Astar 350D helicopter. The soft nature of the sediments necessitated the insertion of plastic casing prior to conducting borehole geophysical tests.

The lignite exploration work in 1982 was successful. An important new discovery was made in an area west of Gentles Township, near the Missinaibi River; the lignite discovered consists of one seam approximately 23 feet thick (including 1–2 feet of carbonaceous clay) at depths of 304–327 feet and a second 9-foot seam at a depth of 334–343 feet. A second discovery was made in southern McBrien Township; here, the main seam is approximately 22 feet thick at 502–524 feet, whereas several thinner lignite seams (3–5 feet) occur between depths of 460 and 492 feet. Holes ONEX-82-05 and ONEX-82-06 encountered probable extensions of the 1981 discovery in East Gentles Township. Hole ONEX-82-06 encountered a relatively thin seam, whereas ONEX-82-05 intersected one of approximately 22 feet thickness at a depth of 246–268 feet and a second, 8-foot seam at 287–295 feet.

The character of the lignite varies. On a dry basis the best samples have heat values greater than 10,000 Btu/lb (approximately 3,400 cal/g). However, many of the samples are in the range of 6,000–9,000 Btu/lb. The moisture content of most occurrences ranges 40–45 weight percent. The ash content is extremely variable, from a low of about 14% (dry) to over 50%. Pyrite is observable in many samples, and the total sulphur content (usually about 65–80% pyritic S, with the remainder as organic S) varies from about 1% to 3.5%. The ash is dominated by clay (largely kaolin), but silica and pyrite are conspicuous in some samples. Trace-element geochemistry on two typical lignite samples has indicated possibly anomalous amounts of platinum.

Sedimentary features in the Cretaceous units suggest that the lignite probably formed in a vertically accreting river system, which drained principally to the northwest.

Palynological evidence confirms a Middle Albian age (approximately 100 m.y. B.P.) and suggests that the paleoclimate was moist and temperate, although at times it may have been warm. The sedimentary model indicates that the thickest lignites would probably form on the leeward side of river levees and along the margins of the river valley. Thin but laterally extensive lignites could accumulate in swampy areas between main river channels.

The silica sands routinely sampled in the 1982 program would be suitable for a variety of industrial purposes, although beneficiation and size classification could be required for some uses. Most of the Cretaceous clays are not suitable for high-quality industrial applications, but could meet some ceramic and building-product specifications. It is likely that higher-quality kaolin clays of significant economic value occur within the Cretaceous sedimentary Basin.

Routine heavy-mineral analyses of Cretaceous and Pleistocene clastic units produced one significant anomaly. This consisted of a concentration of pyrope garnet in a restricted section of Cretaceous sands in the southeast corner of McCuaig Township. Pyrope is one of the key indicator minerals used in diamond exploration, and this find is considered very important.

Oil shale evaluation included sampling bedrock exposures of the Long Rapids Formation near Williams Island on the Abitibi River. In addition, several drillholes were deepened in order to get fresh cores of oil shale units from central parts of the licence area. Results indicate total organic carbon values of 7–10 weight percent, over significant thicknesses. Fischer Assays indicated oil yields as high as approximately U.S. 8 gallons per short ton over significant thicknesses.

Other commodities in the immediate vicinity of the OEC licence area include continuous peat bogs, gypsum, and limestones. These commodities occur in great abundance. It is unlikely, however, that they will be of economic significance in the near future unless they can take advantage of an extensive infrastructure that could be established as the result of a large lignite mining operation.

The 1982 drill program clearly confirms the potential for developing large lignite reserves in the James Bay Lowland. Areas in the central part of the Cretaceous Basin have been proven to contain major lignite occurrences, despite the fact that some lignite may haved been scoured away by Pleistocene glaciation or Late Cretaceous erosion. The discoveries in the vicinity of Gentles Township indicate that there are likely to be significant undiscovered lignite occurrences north of the Missinaibi River. Occurrences discovered in 1981 and 1982 are relatively thick, but their lateral extensions appear to be irregular. In this respect, they may be similar to the 200-million-ton Onakawana deposit. Most of the new discoveries are at depths beyond the present limit of conventional surface mining operations. Other concepts such as borehole-slurry mining or in-situ gasification may be the best approach to exploiting the energy potential of the deeper lignite occurrences.

As a result of the 1982 field program, the following recommendations are made:

1) A regional drill program in the northern part of the reduced OEC licence area is warranted. Approximately 20 holes at spacings of 5 km would be required to cover the area adequately.

2) Detailed drilling is warranted in the immediate areas of the 1981 and 1982 discoveries. A total of 18 holes at spacings of 2–3 km are needed to broadly define the extent of these three discoveries.

3) One hole should be drilled to verify and better evaluate the pyrope anomaly in southeastern McCuaig Township. A large reverse-circulation bulk sample from the anomalous intersection should be taken in order to do a very detailed examination of the heavy mineral suite. Confirmation of the anomaly would warrant taking a very large bulk sample in order to see if the sand contains any diamonds. Closely spaced step-out drilling is also recommended if the pyrope anomaly is fully confirmed.

4) Several drillholes should penetrate the Long Rapids Formation in order to sample oil shale horizons within the unit.

5) Cretaceous silica sands and clays should be systematically logged and sampled. Routine industrial tests should be carried out on selected samples.

6) Heavy mineral studies should be carried out on all Cretaceous clastic units.

7) Alternative mining schemes such as the borehole-slurry mining system should be carefully investigated. If a very large bulk sample (100 tonnes) of the pyrope-rich sands is justified, then this could provide an opportunity to conduct a pilot test of the borehole-slurry system.

8) A pre-feasibility study on possible peat, gypsum, and limestone operations is also recommended.

2. INTRODUCTION

2.1 GENERAL

The contents of this report are concerned with the results of the 1982 field season in the James Bay Lowlands of northern Ontario (see Figure 1). The program extended from June 11th to September 18th and involved drilling 18 holes within the OERL licence area. Included in the program is an examination of the heavy minerals in Pleistocene and Cretaceous clastic sediments to assess the possible occurrence of diamonds, gold, base metals and, in Pre-Cretaceous units, uranium. Also, very limited testing of Devonian oil shale was integrated into the program.

2.2 LOCATION AND ACCESS

East of the Missinaibi River are the 1,050,000 acres that constitute the OERL exploratory licence area (see Figure 2). In the 1982 field season, land access was provided by an all-weather road to Kipling Dam on the Mattagami River, north of Smoky Falls. In previous years, the Ontario Northland Railway (ONR) line, which is located between Cochrane and Moosonee and cuts across the most eastern corner of the licence area, was the only available access to the licence area. Throughout the year, three weekly return runs are made by the ONR; this schedule is supplemented with additional trips in the summer months, to accommodate tourists visiting Moosonee.

A winter road, which was built in 1975 from Kipling Dam northwestward across the Missinaibi River to the north side of the Soweska River, provides additional access to a large part of the area. Moreover, if all-terrain vehicles were operated, the road could prove to be of some use in the summer months.

In the summer, the greatest accessibility is available by helicopter, however, small shallow draft boats can be used on the major rivers such as the Missinaibi and Mattagami.

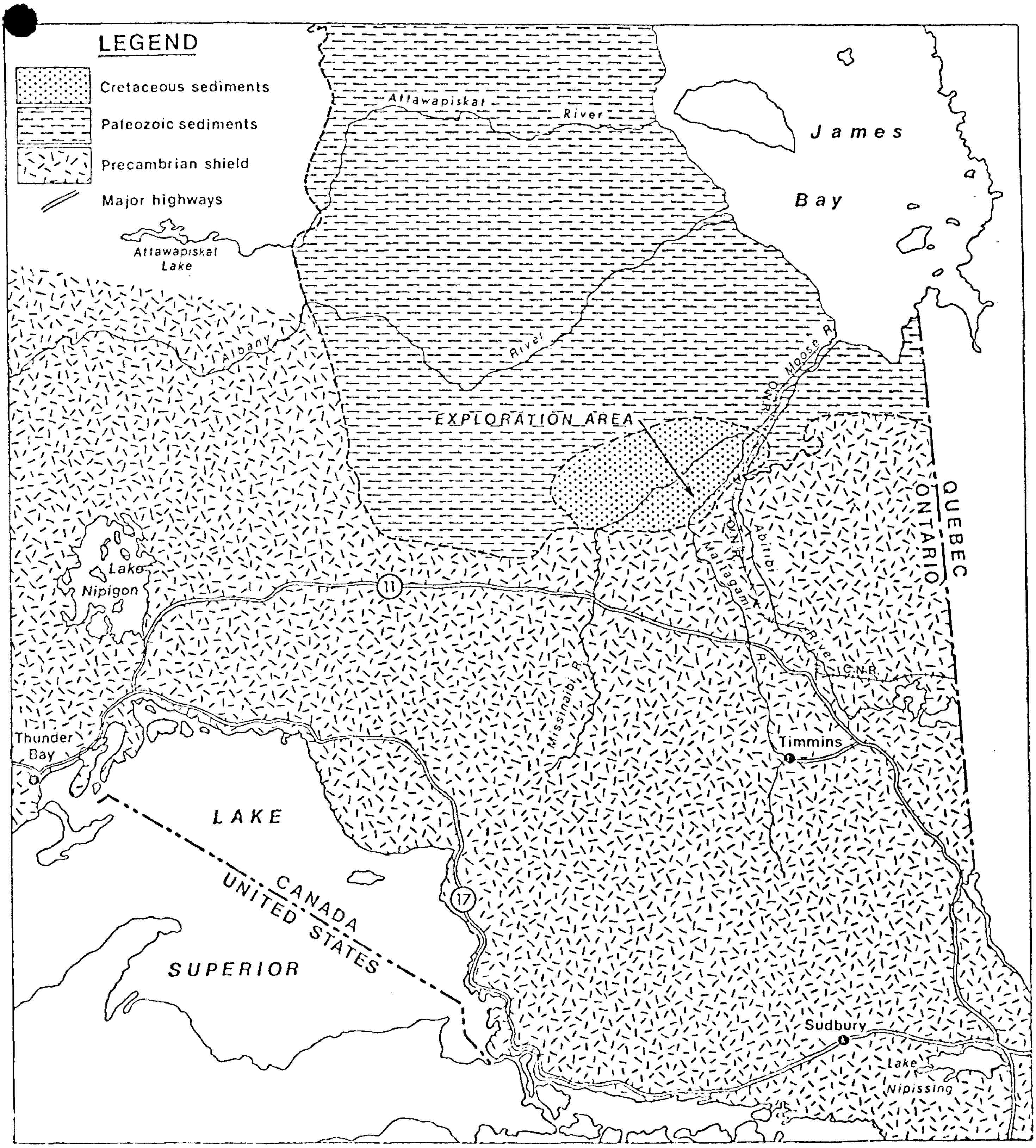


FIGURE 1: General location of the 1982 exploration area.

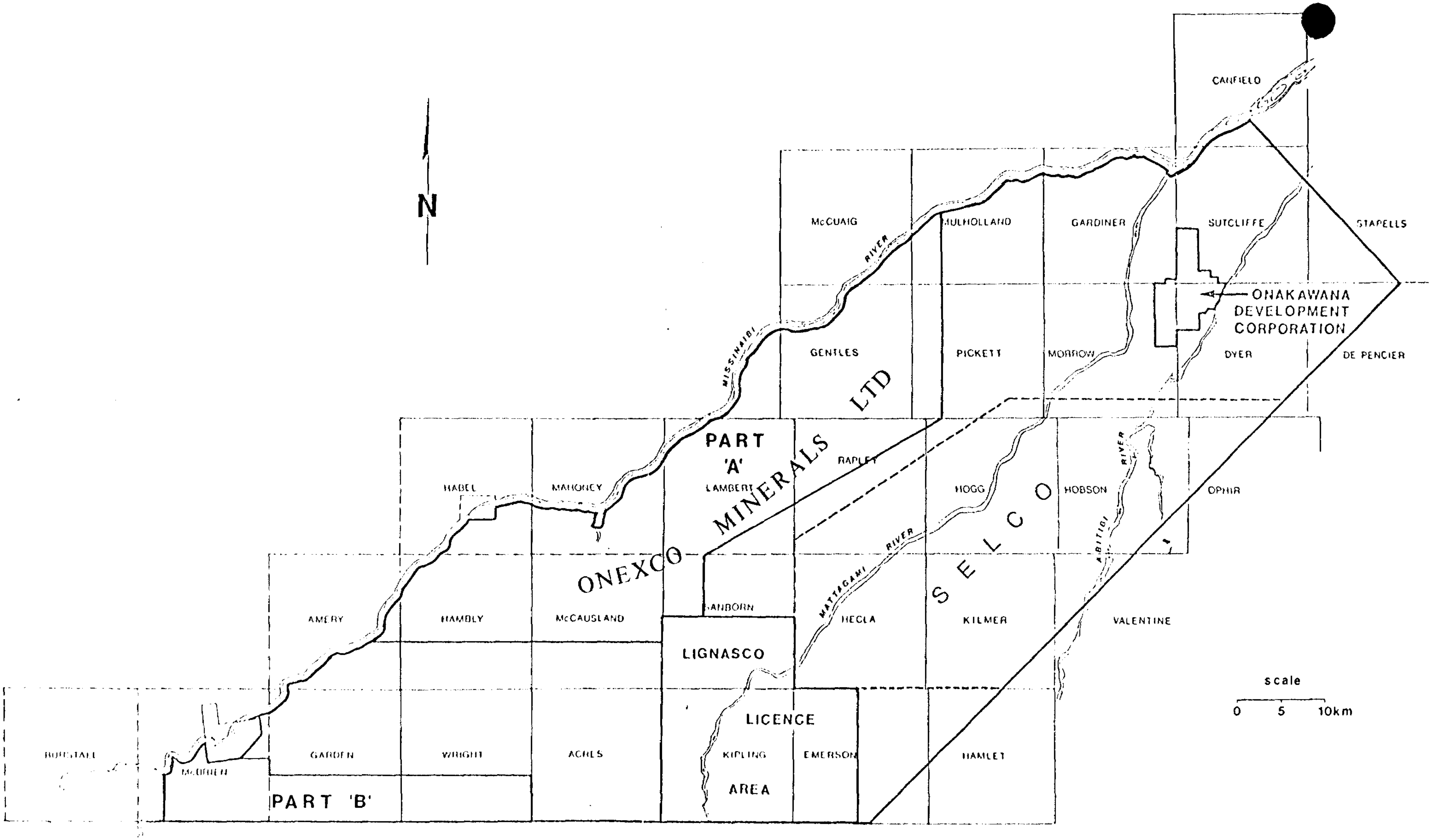


FIGURE 7: General outline of OERL licence area. A larger map is contained in the map pocket of this report.

FIGURE : Typical views of James Bay Lowland topography. Cut line in top photo is an old winter road. Wawa Lakes in the lower photo.

All-terrain vehicles and snowmobiles provide a suitable means of transportation during the winter months; nevertheless, difficulties may be encountered when crossing the rivers, so it may be necessary to construct ice bridges to further the access to the region.

2.3 GEOGRAPHY AND CLIMATE

The licence area is located primarily within the Cretaceous Basin at the southern edge of the James Bay Lowland. Maximum elevations of 150 m (500 feet) are attained along the southern margin of the plain; whereas, surface elevations of approximately 60 m are more typical of the area near the confluence of the Missinaibi and Mattagami Rivers. A regional slope of 1 m/km is characteristic of the licence area; the greatest relief lies along stream channels, where moderately steep banks of 20 m are common. Natural levees, which occur a few metres above the muskeg, usually cap these steep banks.

The most prevalent varieties of trees in the region include spruce, pine, birch, and poplar, which are sparsely distributed among the extensive unconfined peat bogs. These denser forms of vegetation are usually limited to areas where the drainage is good, such as along the edge of streams. Stunted black spruce appears to be the most common form of vegetation in the bogs.

The average mean daily temperature in the lowlands is approximately 12°C (54°F). Temperatures as low as -30°C (-22°F) may be reached during the winter months; whereas, temperatures of 25–30°C are typical of the summer months, from early June to early September.

A mean annual precipitaiton of 350–400 mm (approximately 15 inches) may be expected to be uniformly distributed throughout the year.

During the 1982 field program, the weather was suitable for effective field work. Early morning fog presented an occasional problem, resulting in delays in helicopter travel. Nonetheless, poor weather rarely affected drilling progress throughout the summer months.

2.4 PREVIOUS WORK

Lignite deposits in the James Bay Lowland originally became the subject of geological interest in a report by W. A. Park written in 1899. Although interest in potential deposits waned briefly after 1911, there was a period of renewed interest in the 1920s(?) when lignite investigations also included an examination of the fireclay, silica sand, and oil shale potential in the region. At present, it is not necessary to elaborate on earlier works since an in depth summary is available in the 1980 report by WGM.

More recent investigations of the economic possibilities of the James Bay Lowland include the operation of two major drilling programs by the ODM in 1975 and 1978. The programs entailed the drilling of six holes and eight holes, respectively; most of these holes penetrated the Devonian contact. In addition the ODM drilled three holes near Onakawana in 1977.

Unfortunately, most of the drilling has been restricted to the southern margin of the Cretaceous Basin; reconnaissance drilling has played only a minor role in drilling programs, thus knowledge of the regional geology is limited.

In 1981, WGM carried out an extensive drilling program involving twelve drillsites located in the OERL licence area. Lignite occurrences were found in several of the 1981 OEC drillholes. A substantial lignite seam, approximately 5.2 m thick, was intersected in OEC-81-12, in Gentles Township. As a result of this discovery, several of the 1982 drillsites were placed in the vicinity of OEC-82-12, in an effort to better define this lignite occurrence.

2.5 CONDITIONS AND RIGHTS

Exploratory licence No. 14889 was issued to OERL in 1980. The licence covers an area of approximately 1,050,000 acres and is renewable over three years. The conditions of the licence state that over three years the exploration expenditures must total

$270,000 for the first year, $1.20 per acre or $1,200,000 (whichever is greater) the second year, and the greater of $2.50 per acre or 2,500,000 in the third year.

Each year the OERL must post letters of credit for the exploration expenditures required that year. Also, to ensure that obligations apart from the exploration requirements are met, a $100,000 security must be posted. Lastly, an annual licence fee of $1,000 is required.

The permit for exploration includes all minerals and certain fossil fuels — lignite, oil shale, and peat. Moreover, the OERL has rights to carry out exploration for lignite and oil shale in the Selco Inc. licence area.

During the 1982 field season, the OEC decided to decrease the licence area to a total of approximately 280,000 acres, more or less. The two main areas of interest are seen in Figure 2 . This should result in a reduction of obligatory expenditures and enable a more detailed assessment of areas containing known lignite occurrences.

Futher conditions and rights that are imposed on exploration activity in the licence area have been included in the 1981 summary report by Watts, Griffis and McOuat. In the two years that the drilling program has been in operation, every effort has been made to ensure that all regulations are strictly adhered to.

2.6 OBJECTIVES OF THE 1982 FIELD PROGRAM

During the 1982 field program, several aspects of the economic potential of the James Bay Lowland were investigated:

i) The primary objective of the 1982 drilling program was to delineate lignite deposits by drilling in the vicinity of the 1982 lignite discovery in the Gentles Township — six of the 18 holes were drilled in this region.

ii) Additional drilling was to be carried out on a regional scale to evaluate areas that had not undergone previous work. It was intended that if the results proved to be unfavourable, then these regions could be dropped from the licence area to limit future exploration expenditure requirements.

iii) Careful examination of any Cretaceous silica sand (with or without clay) and clay units was included in the program in order to assess the economic potential of the sample material.

iv) Samples were taken systematically within the Pleistocene and Cretaceous sediments and heavy minerals concentrated and examined optically. It was hoped that the presence of kimberlite indicator minerals would reveal the occurrence of a buried kimberlite dyke (diamonds). Moreover, by implementing this procedure, the possible presence of gold, base metals, and uranium could be detected.

v) Extension of a few selected holes into the Long Rapids Formation was included in the program in order to evaluate the oil shale potential of this unit. Also, additional work on the Devonian strata in the form of surface sampling near the William's Island was planned for the 1982 program.

2.7 ACKNOWLEDGEMENTS

Wayne Brush, Manager of Ontario Energy Resources Limited, Technical Coordinator D. McLean, and Project Officer C. McCue were most cooperative in assisting the project operations in all aspects of the 1982 program.

The WGM personnel principally responsible for the 1982 drilling program included: J. F. McOuat, senior consultant; R. J. Griffis, project manager; J. M. Stratman, project geologist; S. A. Young, junior geologist; field engineers G. Shelp and J. A. Rae; and field assistants M. Smaill and D. Lawrence. The report was principally written by R. J. Griffis, J. M. Stratman, and S. A. Young; section 7.6, concerning oil shales, was written by P. G. Lalande and M. C. Ward. L. Waterman, J. Michalik, and F. Pietras were instrumental in the preparation of this report.

Drilling was contracted to Heath and Sherwood Drilling of Kirkland Lake. The work was effectively organized by G. White. Moreover, G. Howg performed exceptionally as both a driller and foreman in the 1982 field program.

The helicopter contract was awarded to North Star Helicopters Limited of Hearst. Harold Webster, pilot, and Dan Lamarche, helicopter maintenance engineer, did outstanding jobs, often working long hours to ensure that the helicopter would be available for shift change.

Geophysical logging was successfully carried out by M. Brain of Century Geophysical Corporation of Calgary, Alberta.

Further acknowledgements should include N. Voss and L. Luhta of the Ontario Ministry of Natural Resources, whose cooperative efforts were greatly appreciated by WGM personnel.

3. LOGISTICS

3.1 FIELD CAMP AND SUPPLIES

The 1982 field camp (Figure 4) was located in an old quarry site at the end of the hydro road from Smoothrock falls (km) and Spruce Falls Pulp & Paper Company private road from Kapuskasing (km). This was an ideal location because of its road access and the proximity to the areas only fresh water supply.

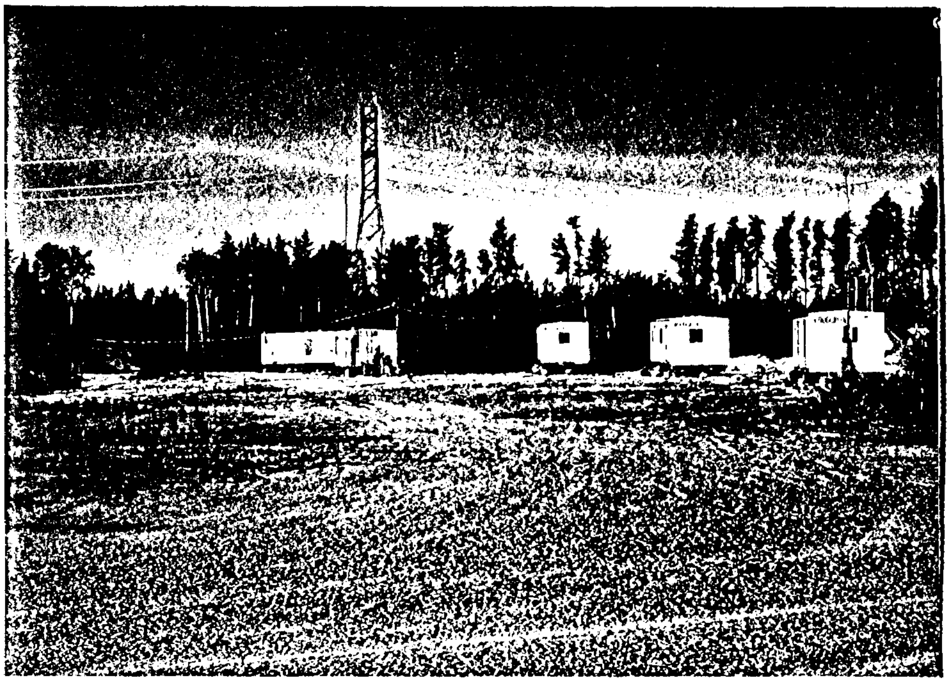
The camp was at the southeast end of the drilling area with the longest helicopter commute taking approximately 25 minutes.

Heath & Sherwood supplied complete camp facilities, except sleeping trailers for WGM personnel, as part of the drill contract. The camp consisted of a kitchen/dining trailer, sleeping trailer for drillers, dry with sinks, shower and washing machine, and toilet facilities.

Electricity was provided by a 15 kw diesel which provided sufficient power to run the refrigerators and freezers and to supply lights for all trailers. The camp had a gravity water system plumbing directly from the quarry to the kitchen and dry, which also had a pressure system for the shower and sinks. Cookstoves and waterheaters, in the kitchen and dry, utilized propane.

Meals were supplied to WGM personnel by Heath & Sherwood on a per meal cost basis. Groceries were purchased in Smooth Rock Falls on a weekly basis.

Hardware and miscellaneous gear was purchased in Kapuskasing as much as was possible. Charge accounts were set up with several businesses.



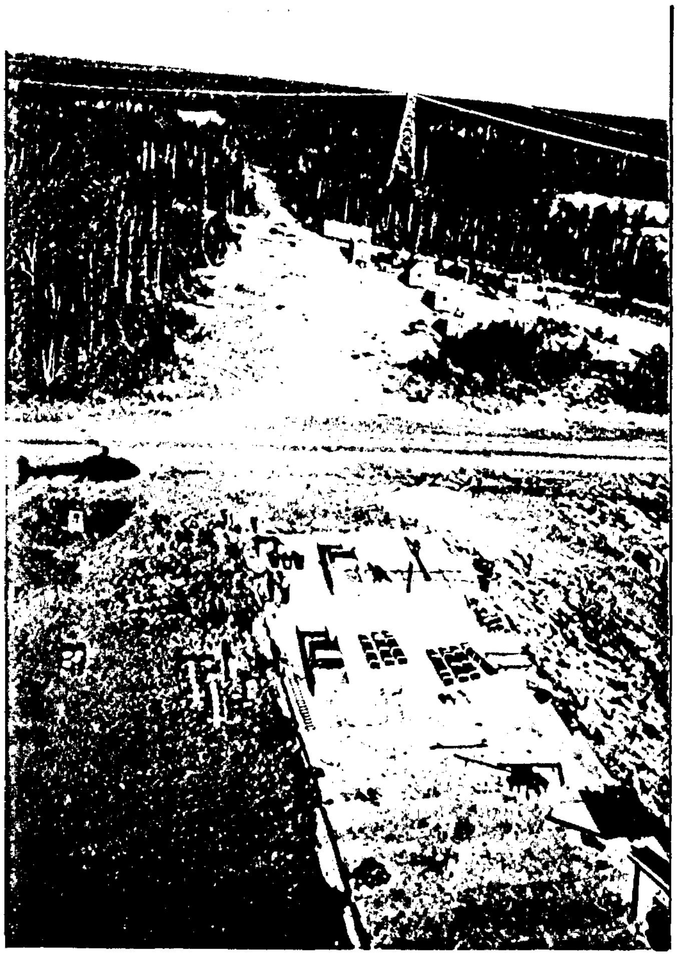


FIGURE : View of 1982 field camp north of Smoky Falls. Cement platform in lower photo used to load and unload drilling equipment.

3.2 HELICOPTER SUPPORT

Again in 1982 program design indicated that a helicopter supported program would be the most cost efficient. An Astar 350 was contracted from North Star Helicopters of Hearst because of favourable experience during the 1981 field season. The helicopter was used for moving personnel, supplies and the drill rig.

The drill rig was designed to be helicopter portable and as such broke down into pieces that weighed less than 1,500 pounds. The Astar was able to lift the heavy loads with relative ease under normal conditions.

The Astar 350 was found to be extremely reliable this summer with little downtime because of helicopter problems. While a few major problems did occur that could have caused major downtime, they were discovered early and either repaired during the night or the ship was replaced until the problem was corrected. A contracter with a base close by was chosen because of the spotty performance of the Astar in the past. The bugs are being worked out of the Astar and it would be a good choice again for a program of this type.

3.3 COMMUNICATIONS

Good communications are necessary for a project of this type because of the dangers and expense involved. A good system was attempted this season but met with poor results.

The following communicatons network was set up:

(1) A portable telephone was again rented from Ontario Northland Communications. The unit was never successfully operated because we were just out of range of the fringe station at Fraserdale. ONR engineers were very helpful in trying to get the unit functioning but we were just too far away.

(2) Portable high-frequency radios were provided by Heath & Sherwood. Units were set up betweem camp and the drillsite and a different frequency was utilized between camp and the Heath & Sherwood shop

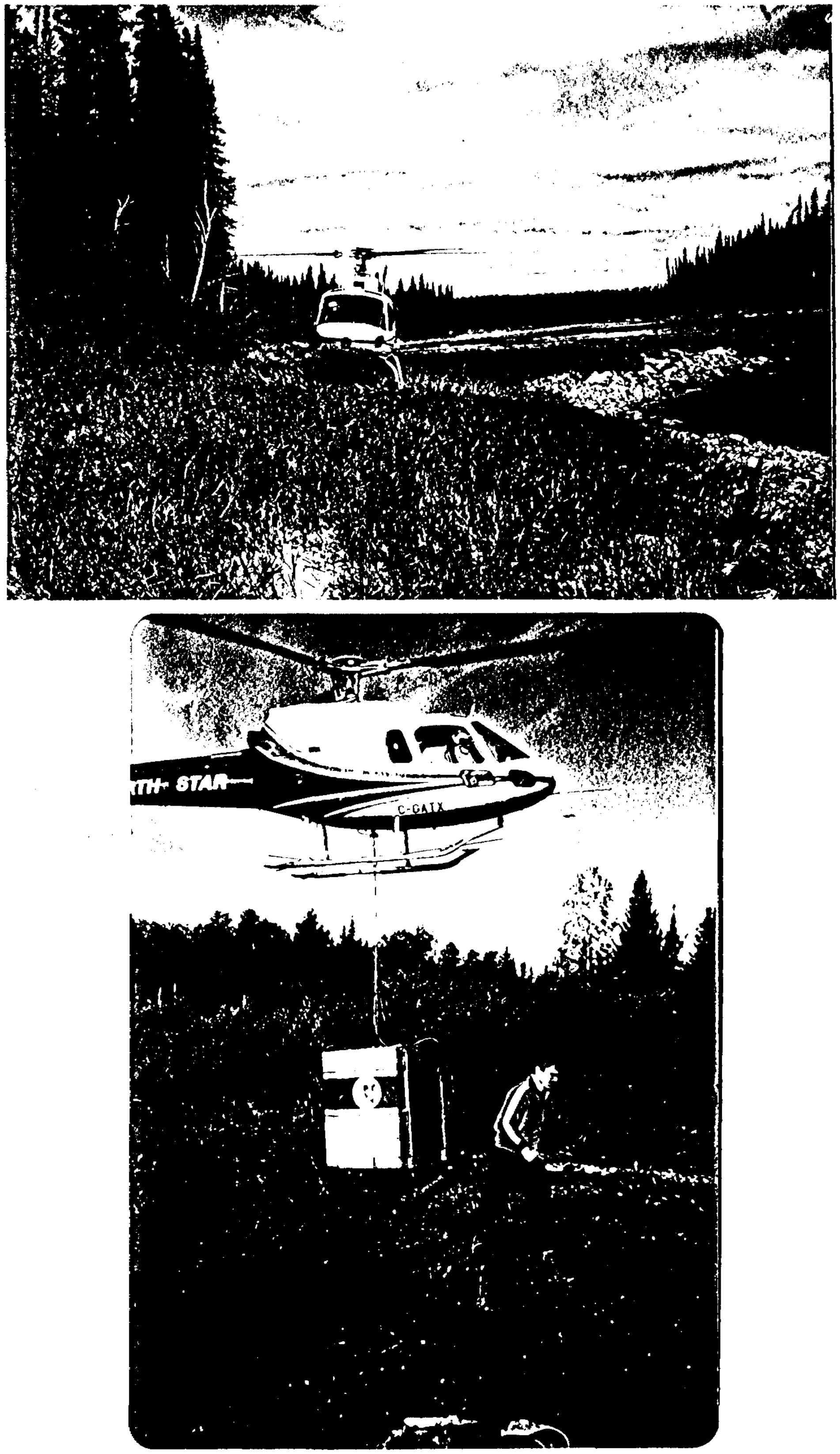


FIGURE : Astar 350D helicopter. Reconnaissance work along major river in the top photo. Slinging geophysical equipment in the lower photo.

in Kirkland Lake. The helicopter was equiped with an HF radio and a link was attempted between both the camp and drillsite. The HF system never did operate reliably between camp and the drillsite and was only marginally successful between camp and Kirkland Lake.

(3) The helicopter was able to communicate with other aircraft in the area and at times with their base station in Hearst. The helicopter crew had a portable radio which provided short range, line-of-site communication between ship and ground.

(4) A telephone was generously made available to us by personnel of the Spruce Falls Power Station at Smoky Falls. The signal was extremely variable over this phone. More important calls were usually made from telephones at Onakawana when working nearby or were made from Kapuskasing.

(5) Motorola portable radios were rented following an accident in early July which demonstrated clearly the need for a better communictaion system. These radios had line-of-sight ranges of 30–50 km. We still could not communicate directly between camp and the drillsite so a mandatory contact time was set up on day shift and the helicopter would be in the air at that time. In addition, when cutters were out they were checked at more frequent intervals.

Obviously better communications will need to be set up for further programs. Some possibilities are:

(1) Have ONR engineers design a radio telephone system. Stronger radios are available; the possibility of increasing the effectiveness of the present system with a higher antennae should also be investigated.

(2) The Motorolas were quite reliable. They should be used again with the addition of a stronger base station if available and higher antennas at camp and drillsites. It may be necessary to rent a portable tower (e.g. 100 feet). In addition, one of the portable radios should be wired into the helicopter so the pilot can monitor constantly and is also able to key the radio from his cyclic trigger. Perhaps Motorola engineers could put together a reliable package with proper lead time.

4. DRILLING TECHNIQUES

4.1 REVERSE CIRCULATION DRILLING

Reverse circulation has proven to be the most efficient method of drilling in overburden and unconsolidated materials.

The method utilizes a double-walled pipe (Figure)with a tricone bit. A compressor and pump supplies air and water down the outside chamber of the rods and washes the drilled material up the centre chamber. The material is travelling at high velocity when it reaches the surface and is directed into a cyclone, which slows the return and directs it down through a sieve and double bucket system where it is logged and sampled.

Reverse circulation drilling allows rapid penetration and generally good recovery throught tills, sands, and gravels. Clay units can be difficult to penetrate and the drilling rate is usually quite slow. Boulders are frequently encountered in the tills and are usually drilled through with few problems. When drilling in tills the material arrives at the surface as a slurry, sand is easily recognized. Rocks come to the surface either unbroken or as chips, depending on the size of the rock being drilled. Clays come up as shavings or lumps; if very soft clays are penetrated, they can be washed away and lost. The material can be logged quite accurately after a short training period. Because of the velocity of the return, little lag time is encountered between what is being drilled and what is observed at the surface; therefore, sharp contacts can be accurately logged.

The first several holes were drilled with 3 7/8" dual tube rods. The drilling was slow due to clays plugging the rods and bit which necessitated pulling and clearing. This occurred because of poor seals on the rod connectors and misalignment of the inner tube which allowed the pressure to escape through the weakest point whenever the bit plugged. When 3 7/8" dual tubes in good condition could not be readily supplied, it was decided to substitute 2 15/16" dual tube rods. These rods had simpler connections so

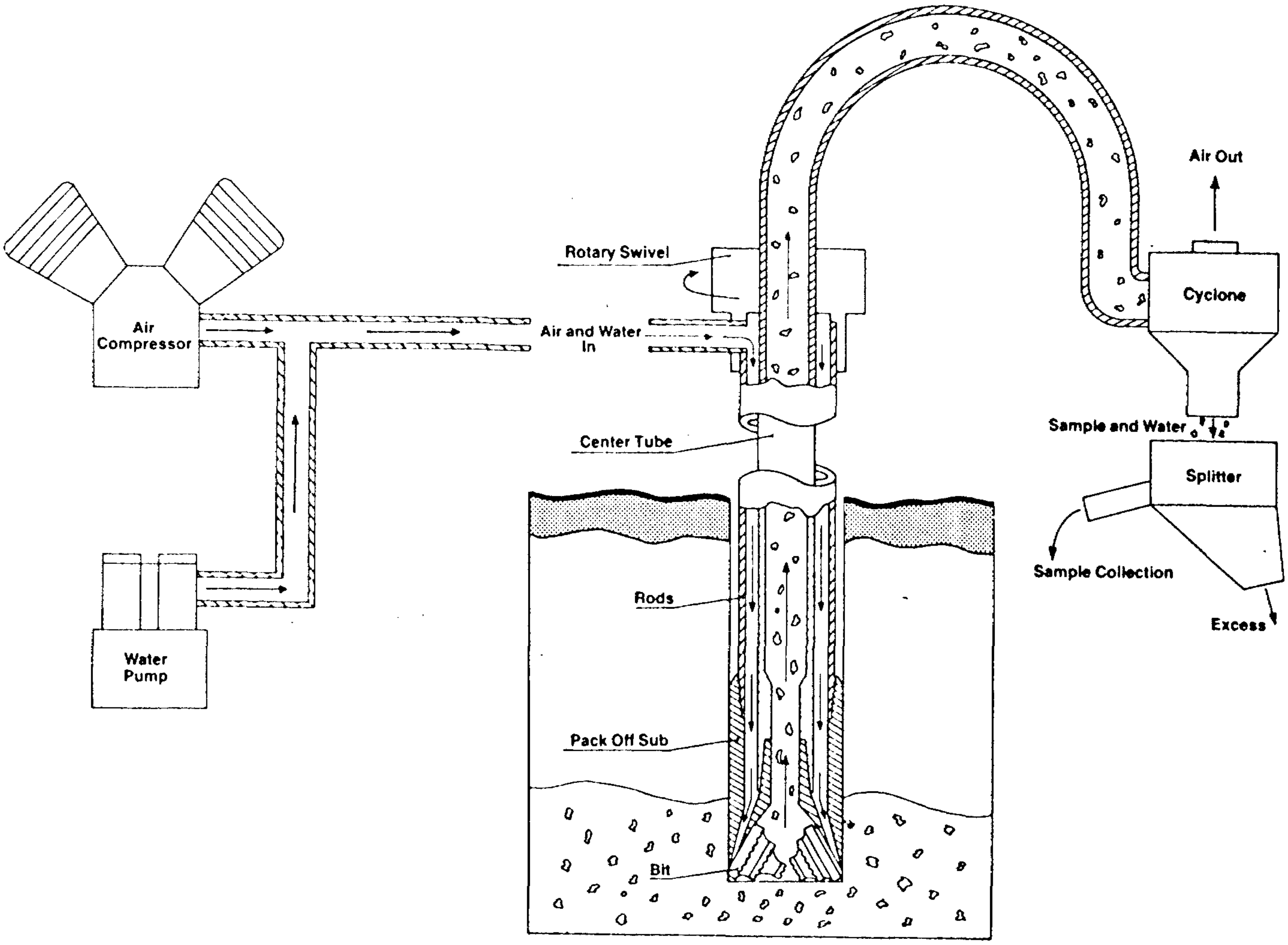
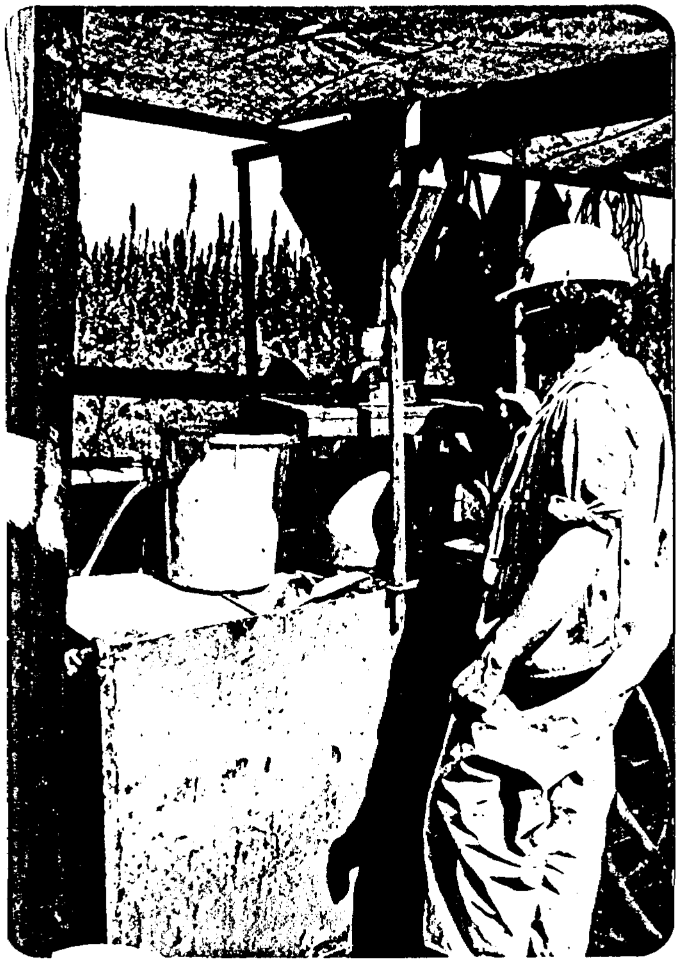


FIGURE : Diagrammatic sketch of reverse circulation drill system (modified from Heath & Sherwood).



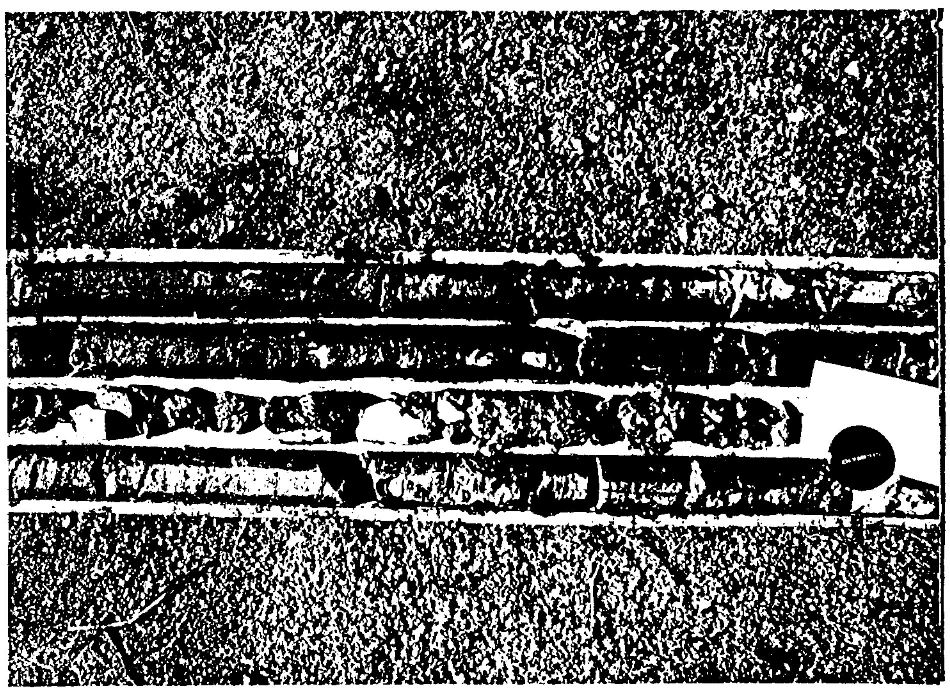
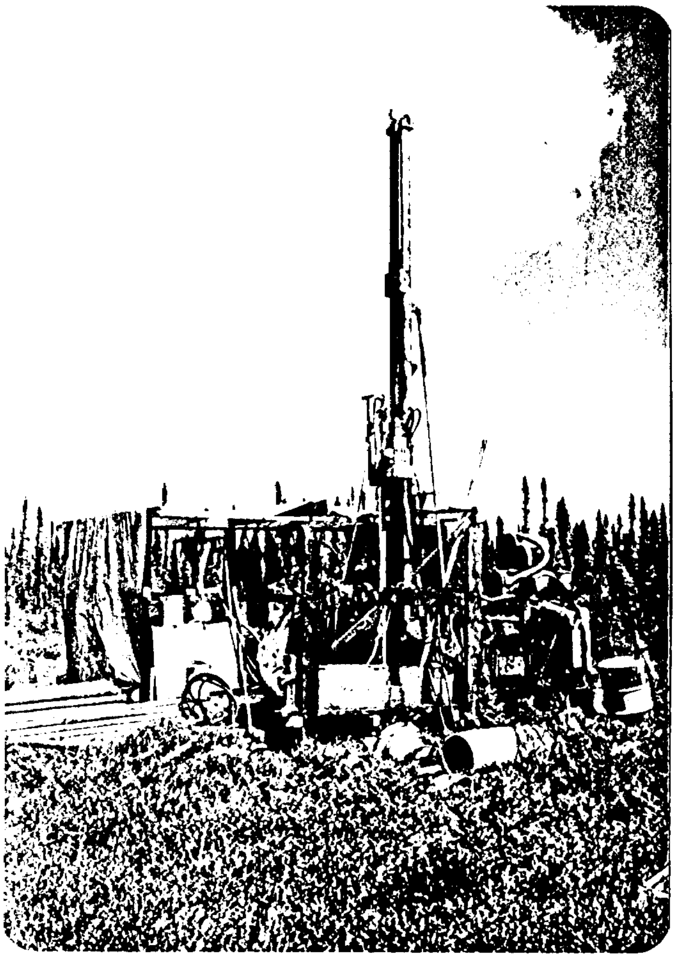


FIGURE : Reverse circulation cuttings (above) and core. The reverse circulation sample is largely collected in the two plastic buckets although fine material (clay) does get washed out. Core in the lower photo is NQ.



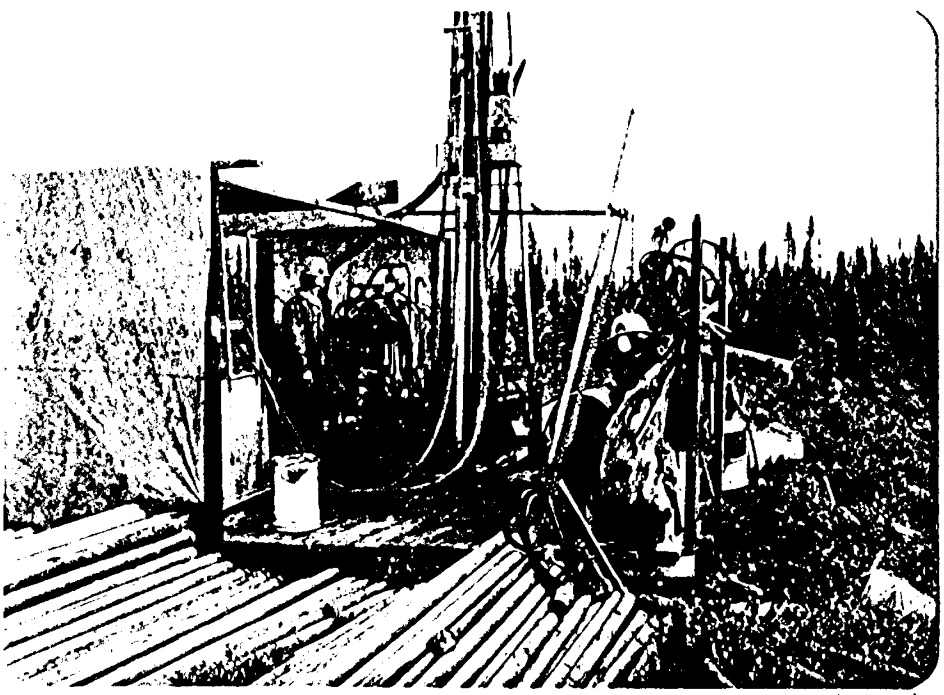


FIGURE : Acker P38 drill. This machine has been adapted to suit a helicopter-supported drill program.

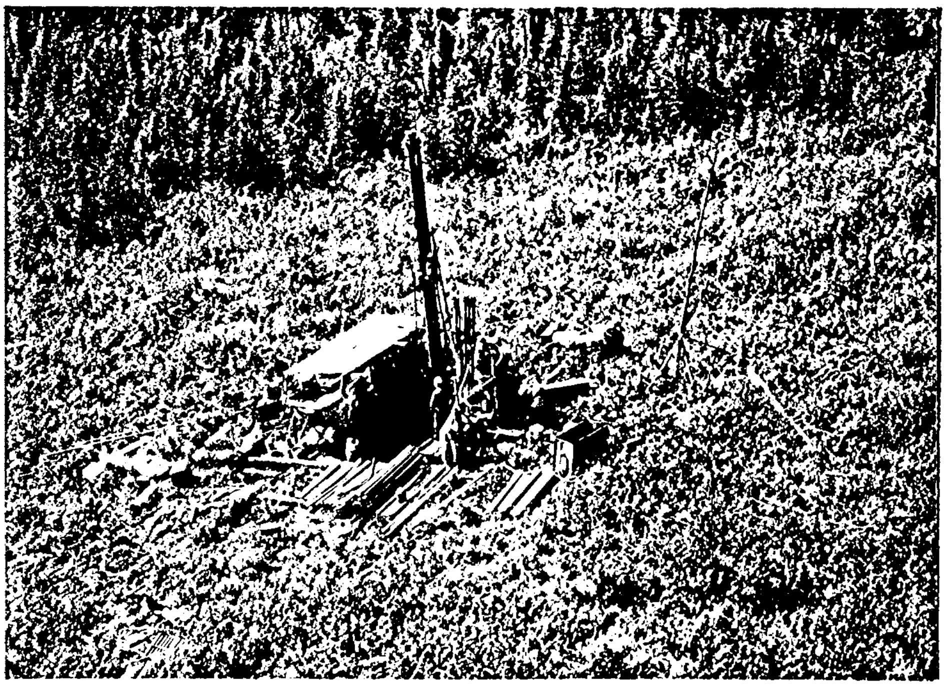


FIGURE : Typical view of drillsites. Most areas selected are close to water (above) and do not involve extensive clearing (below).

there was less plugging due expressly to equipment problems. The main disadvantage of the 2 15/16" dual tube system is that it provided a smaller sample, but this was an infrequent problem. The advantages were faster drilling, because of fewer equipment problems, and fewer helicopter loads to be moved since NW casing could be used for 2 15/16 dual tubes and NQ wireline rods.

Two types of tricone bits are used in reverse cirulation drilling: mill-tooth and carbide button (Figure). Mill-tooth bits cut through clay better than button bits but wear quite rapidly in gravels and boulders. Their cost is approximately half that of the button bit. Button bits penetrate clay slowly and function better in harder lithologies such as gravel and boulders. On average a carbide bit would last one hole (400 feet) depending upon the material encountered. These bits were usually destroyed because of excessive bearing wear or cutting off the shirt-tails.

Experienced and cautious drillers are needed when using reverse circulation techniques in unconsolidated material and clays. The rods are easily plugged when rapid changes from sand to clay are encountered. As a result, drilling time is lost since the rods and bit must be pulled and cleared. Alert drillers can sometimes prevent this. Drilling too rapidly through thick sand units can result in 'worst case' situation of sanding the rods in the hole, thus preventing rotation or pulling back of the string which may lead to shearing off of the rods or damaging the drill while trying to free the rods.

Reverse circulation holes, as a rule, must be cased. Pleistocene units (with clay binders e.g. tills) will usually remain open but sand units will collapse resulting in downhole contamination and the possibility of sanding the rods. Standard practice during the 1982 program was to drill into the sands until a problem was encountered (e.g. plug the rods with sand) or the drill string had entered a clay unit and then case to that depth. Again this helped prevent contamination, protect the drill string and, when possible, enable us to begin coring without long delays.

Drilling mud was used constantly in sands to pack the hole walls and to help clean sand out of the hole before stopping rotation to add rods.

4.2 TRIPLE TUBE CORING

Cretaceous sediments were cored this season whenever the conditions were favourable. A standard diamond drill set up, with the addition of a thin walled split tube inside the core barrel, allowed a relatively undisturbed core to be obtained for examination of small scale sedimentary features or for study of the lignite.

A diamond step bit is used for triple tube coring. Diamond bits are constructed to penetrate hard materials so bit life is quite long in clays, shales, and limestones. The same diamond bit was able to be used all summer because of the softness of the material being drilled.

Problems similar to those encountered in reverse circulation drilling do occur especially when sand is encountered. A thick sand unit can cause the rods to become sanded, leading to loss of the drill string, bit, and core barrel. Occasionally the core barrel will become sanded inside the drill rods and can be separated only with great difficulty. It is necessary to case off any sand encountered, wash the hole with mud, and to have knowledgeable and experienced drillers.

4.3 DRILLING SUMMARY

Statistics on the 1982 drilling program are summarized in Tables 1 - . A copy of the drill contract is included as Appendix of this report. The drill program was more successful than planned. The original goals (12–15 holes) were surpassed due to a more advantageous contract enabling us to drill more holes than planned and also due to a minimum of costly downtime, but most of all because of a superb project geologist. Moving and set-up times were kept to a minimum through planning loads and locating holes close to water supplies so long water lines did not need to be laid. The drilling program was terminated at the completion of OEC-82-18 on September 3rd.

TABLE 1

SUMMARY OF DRILLING DATA

HOLE NUMBER	HOLE DEPTH	REVERSE CIRCULATION FOOTAGE	CORING FOOTAGE	OVERALL CORE RECOVERY	TOTAL HOURS FOR COMPLETION	COMMENTS
OEC-82-01	88.7 m 291.0 ft	51.8 m 170.0 ft	36.9 m 121.0 ft	91.0	104.25	3 7/8" D.T.
OEC-82-02	98.1 m 322.0 ft	85.3 m 280.0 ft	12.8 m 42.0 ft	61.7	107.00	3 7/8" D.T.
OEC-82-03	85.3 m 280.0 ft	85.3 m 280.0 ft	—	—	64.50	3 7/8" D.T.
OEC-82-04	135.3 m 444.0 ft	75.9 m 249.0 ft	59.4 m 195.0 ft	72.7	173.00	0-220', 281-290': 3 7/8" D.T. 290-310': 2 15/16" D.T.
OEC-82-05	133.8 m 439.0 ft	81.7 m 268.0 ft	52.1 m 171.0 ft	99.1	96.00	2 15/16" D.T.
OEC-82-06	140.2 m 460.0 ft	95.7 m 314.0 ft	44.5 m 146.0 ft	96.5	85.00	2 15/16" D.T.
OEC-82-07	122.2 m 401.0 ft	104.8 m 344.0 ft	17.4 m 57.0 ft	57.6	104.5	0-234': 3 7/8" D.T. 242-282', 331-401': 2 15/16" D.T.
OEC-82-08	130.5 m 428.0 ft	122.0 m 400.0 ft	8.5 m 28.0 ft	72.9	87.0	2 15/16" D.T.
OEC-82-09	118.9 m 390.0 ft	118.9 m 390.0 ft	—	—	70.0	2 15/16" D.T.
OEC-82-10	121.9 m 400.0 ft	121.9 m 400.0 ft	—	—	67.0	2 15/16" D.T.
OEC-82-11	107.3 m 352.0 ft	100.6 m 330.0 ft	6.7 m 22.0 ft	79.6	60.0	2 15/16" D.T.
OEC-82-12	118.9 m 390.0 ft	112.2 m 368.0 ft	6.7 m 22.0 ft	50.0	94.0	2 15/16" D.T.
OEC-82-13	121.9 m 400.0 ft	117.0 m 384.0 ft	4.9 m 16.0 ft	43.8	77.5	2 15/16" D.T.
OEC-82-14	180.4 m 592.0 ft	109.7 m 360.0 ft	70.7 m 232.0 ft	71.8	121.5	2 15/16" D.T.
OEC-82-15	133.2 m 437.0 ft	103.6 m 340.0 ft	29.6 m 97.0 ft	42.0	96.5	2 15/16" D.T.
OEC-82-16	131.1 m 430.0 ft	131.1 m 430.0 ft	—	—	65.0	2 15/16" D.T.
OEC-82-17	119.8 m 393.0 ft	119.8 m 393.0 ft	—	—	43.0	2 15/16" D.T.
OEC-82-18	125.0 m 410.0 ft	100.6 m 330.0 ft	24.4 m 80.0 ft	100.0	130.0	2 15/16" D.T. Power-pack and compressor down. Result in approximately 6.5 shifts lost.
TOTALS	2,212.5 m 7,259.0 ft	1,837.9 m 6,030.0 ft	374.6 m 1,229.0 ft		1,645.75	
AVERAGE				72.2		

TABLE 2

DRILLING HOURS SUMMARY

HOLE NUMBER	RL DRILLING HOURS	NQ DRILLING HOURS	CASING HOURS	MISC. HOURS	MOVING HOURS	TOTAL HOURS	COMMENTS
OEC-82-01	9.5	44.0	17.75	1.75	31.25	104.25	Moving includes Smoky Falls to OEC-82-01; ( ) km.
OEC-82-02	51.75	14.5	15.0	6.25	19.5	107.0	
OEC-82-03	27.25	—	10.5	9.0	17.75	64.5	
OEC-82-04	36.0	60.5	26.5	27.5	22.5	173.0	
OEC-82-05	22.5	36.0	18.0	4.5	15.0	96.0	
OEC-82-06	17.5	28.5	20.0	6.0	13.0	85.0	
OEC-82-07	54.5	21.0	10.0	4.0	15.0	104.5	
OEC-82-08	24.25	10.5	11.5	28.0	12.75	87.0	
OEC-82-09	30.0	—	13.0	8.0	19.0	70.0	
OEC-82-10	17.0	—	17.5	1.5	31.0	67.0	Long move; ( ) km.
OEC-82-11	8.5	8.5	17.5	2.0	23.5	60.0	
OEC-82-12	39.0	5.5	19.0	11.5	19.0	94.0	
OEC-82-13	35.0	5.0	14.5	3.0	20.0	77.5	
OEC-82-14	26.5	45.5	15.5	13.0	21.0	121.5	
OEC-82-15	30.5	31.0	15.0	1.5	18.5	96.5	
OEC-82-16	26.0	—	24.0	2.0	13.0	65.0	
OEC-82-17	16.5	—	12.5	1.0	13.0	43.0	
OEC-82-18	24.0	15.5	17.0	57.5	16.0	130.0	Mechanical breakdown of power-pack and compressor.
Demobilization	—	—	—	—	33.0	33.0	
TOTALS	496.25	326.0	294.75	188.0	373.75	1,678.75	

Consumable costs (Table) exceeded the budgeted amount. This was due mainly to the replacement of a string of NW casing that was stuck in the hole and ordering an additional 4,000 feet of plastic casing.

Table summarizes direct drilling costs. The cost per foot was approximately $30, which is excellent for a bush program. This figure was achieved by an inexpensive drill contract, adequate drillers and low downtime costs.

TABLE

COSTS OF CONSUMABLES

1982 DRILL PROGRAM

MILLTOOTH BITS, TRICONE	$ 1,760.00
CARBIDE BUTTON BITS, TRICONE	6,984.00
BIT SUBS	1,600.00
HEAD RODS	1,315.80
HW CASING	446.08
HW CASING SHOE	265.65
NW CASING	7,236.84
NW CASING SHOE	690.95
DRILLING MUD	3,714.55
CORE TRAYS	632.50
MISCELLANEOUS	184.75
PLASTIC CASING	19,262.40
TOTAL	$44,093.52

TABLE 4

DRILL COST SUMMARY

MOBILIZATION AND DEMOBILIZATION	$ 4,200.00	
DRILLING	120,545.00	
MOVING	35,468.80	
CONSUMABLE COSTS	44,093.52	
TOTAL	$204,307.32	

TOTAL FOOTAGE	7,259.0 ft	(2,212.5 m)
COST PER FOOT (METRE)	$28.15	($92.34)
AVERAGE COST PER HOLE	$11,350.41	

5. GEOPHYSICAL WIRELINE LOGGING

5.1 GENERAL DISCUSSION

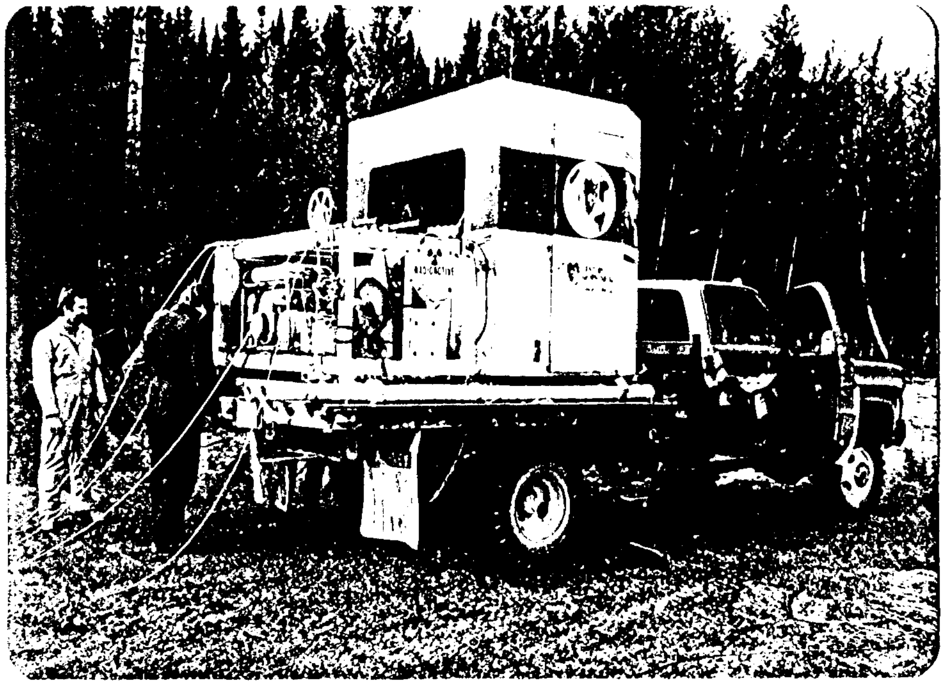
Slim-hole wireline logging through plastic casing was used again in the 1982 program to supplement and check the visual logging of the drillholes. Due to the unconsolidated nature of the material, the only studies deemed useful were natural gamma, density (gamma-gamma) and neutron.

Plastic casing was inserted into each hole before the metal casing was removed. This allowed the plastic casing to sit on or near the bottom of most holes. In a few cases the hole collapsed below the metal casing or hydrostatic pressure caused sand to come up the casing so the plastic could not get to bottom. Another problem encountered was that the plastic casing occasionally hung up at the bottom of the metal casing and then slipped down when the metal casing was removed. The top of the plastic casing was then 5-20 feet below the collar. We were not able to log OEC-82-09 because of this problem.

The logging took place after completion of the drilling. The operator was Century Geophysical Corporation of Calgary, Alberta. The logging unit was helicopter portable in two loads. The first load consisted of a steel framework with winching gear, power plant, and the pigs which contain the radioactive sources. The second load was the instrument shack holding the computer and operating instruments.

The Century Geophysical logging system is based on a digital computer. This allows logging at a higher rate of speed (9 m per minute) and each probe needs to be passed through the hole only once because the data is stored on magnetic tape. A print out can be obtained in minutes after the logging at whatever scale is most advantageous.

The natural gamma log measures the level of natural radiation in the material it is passing through. Radioactive materials are present to some extent in all formations



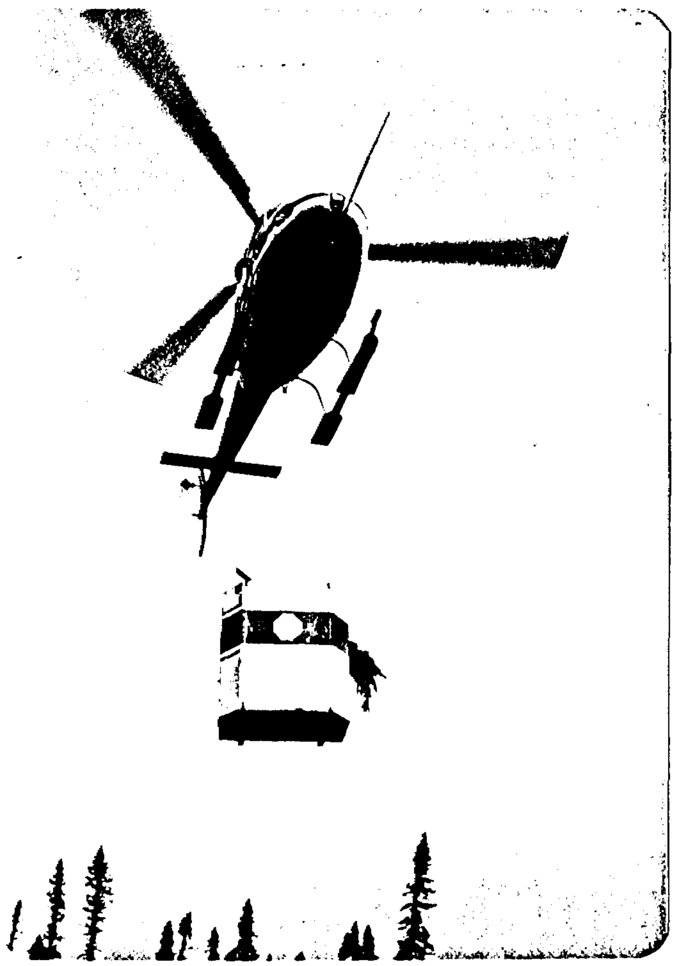


FIGURE : Century Geophysics wireline equipment. The pine 'tail' in the lower photo is attached to the apparatus to keep the load from twisting.

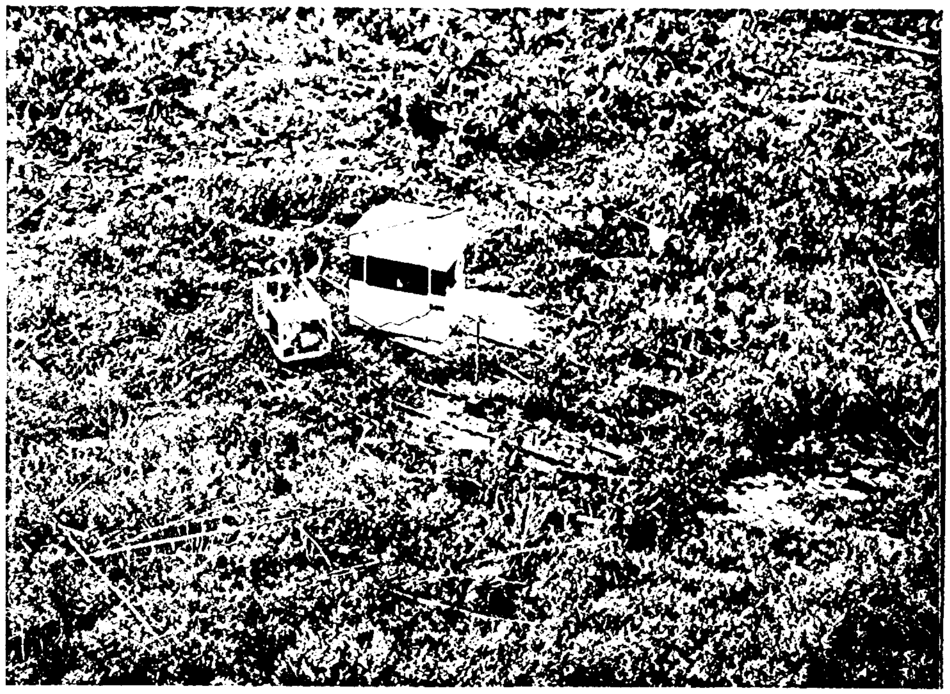


FIGURE : Wireline geophysical equipment at an abandoned drillsite.

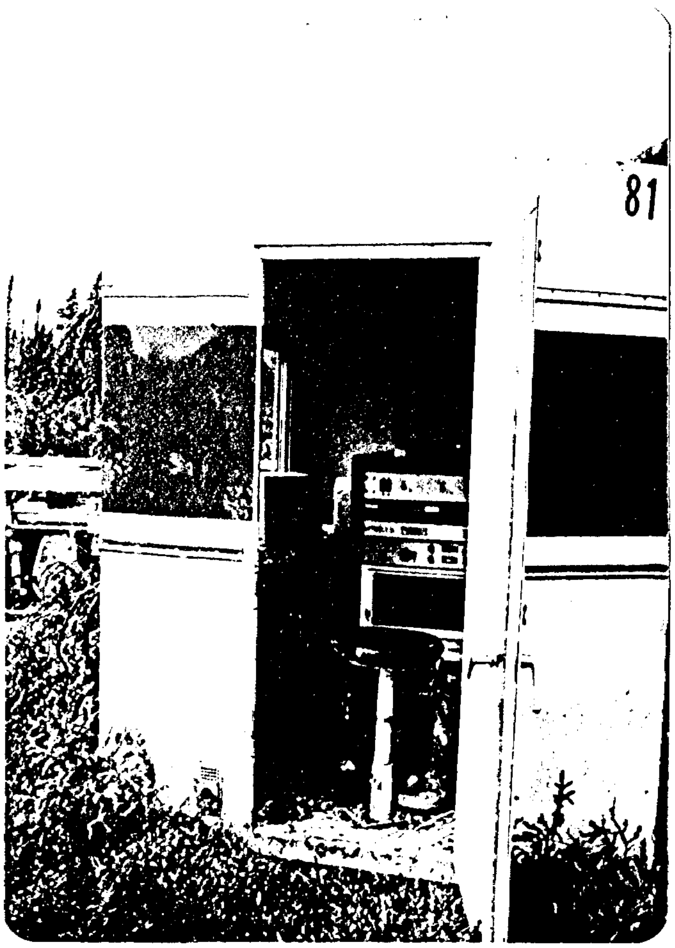


FIGURE : Close up view of the computerized geophysical recording system.

depending on their chemical composition. The gamma radiation of shales and clays is higher compared with that of clean sand, clean limestone, or coal.

The density log (gamma–gamma) measures formation density. The probe consists of a source (Cs 137–125 mCi) and a shielded detector that records backscattered gamma rays from the formation. The secondary radiation is roughly proportional to the formation bulk density.

The neutron probe measures porosity. The source is AM Be-1ci. The detector measures collisions with hydrogen atoms or more simply the amount of water (or hydrocarbons) filling pore space. A low hydrogen density indicates low liquid filled porosity. Water saturated coals and sands would indicate a higher porosity than a granite or limestone. The logs by Century Geophysical in 1982 would tend to suggest the opposite. A lignite would have a low cps because the gamma rays are being absorbed in the water. A higher cps reading would indicate that less water is contained in the formation.

5.2 RESULTS

The most important function of the electric log continues to be that of providing confirmation of the existence of actual lignite seams (versus heavy chip density) and accurate thicknesses. This type of confirmation occured in holes OEC-82-06 and OEC-82-08. We were not able to switch to coring when we entered the lignite seam so the interval was logged with reverse circulation cuttings. Electric logging confirmed the visual logging.

The problem of identifying and correlating the different Pleistocene tills still exists. They do not appear to have individual signatures so identification of the different tills must still be done visually if so desired.

The electric logs are best used along side the lithologic logs. The major unit boundaries are quite distinct (Pleistocene–Cretaceous–Devonian clays or limestone) but interpretation within the major units is difficult without the visual comparison.

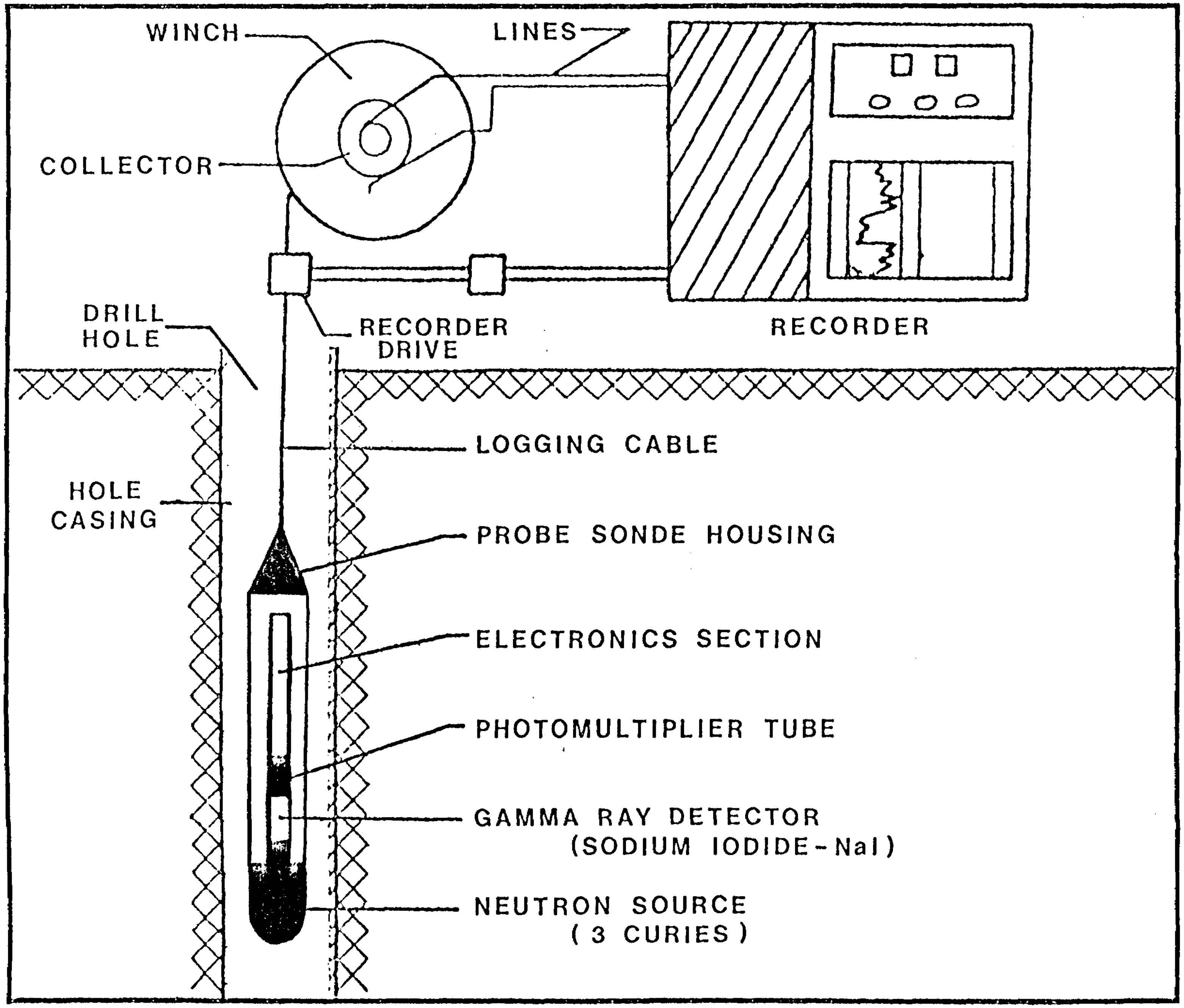
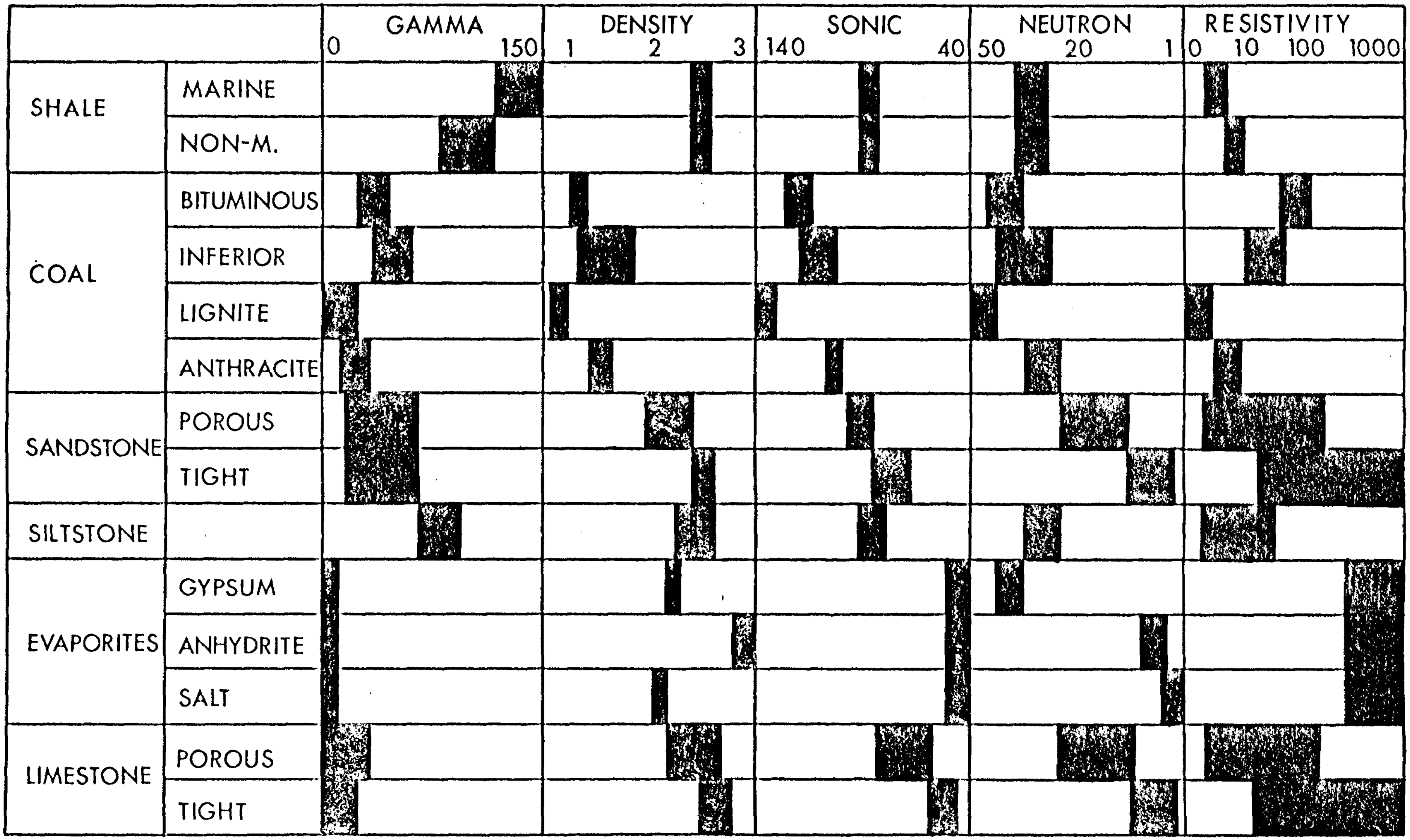


FIGURE 13: Diagrammatic illustration of a wireline electric logging system.

TABLE

LITHOLOGY V. TOOL RESPONSE (SUMMARY)



6. GENERAL GEOLOGY

6.1 RECENT

Overlying the Pleistocene sediments of the Moose River Basin is a thin veneer of recent deposits. These uppermost beds consist of three distinct units; a glaciolacustrine unit, a marine unit and a terrestrial unit.

The glaciolacustrine unit comprises three facies: a) a silty diamicton; b) sand and gravel; and c) silt clay rhythmites. From a hypothetical composite developed by Skinner (1973) to depict the post-glacial sediments (see Figure 14), the glaciolacustrine unit may be seen to be immediately overlying the Kipling Till. Due to their relative stratigraphic positions, the contact between the upper silty diamicton and the underlying till is usually gradational. Moreover, the silty diamicton may acquire a texture similar to that of the underlying till.

The uppermost silt–clay rhythmite facies is often reworked into the overlying clay–pebble gravel. Preservation of the rhythmially bedded silts and clays is quite common; the colour of individual couplets grades from brown at the base to bluish-grey at the upper extent. The blue-grey colour may persist in the unoxidized parts of the overlying marine, clay–pebble gravel.

The incursion and subsequent regression of the Tyrell Sea — a late-glacial and post-glacial sea that occupied the Hudson Bay Basin — resulted in the deposition of the marine unit. By far the greatest volume of post and late glacial sediments in the Moose River Basin is contributed by this particular unit.

The marine sediments consists of three facies:

a) the basal clay-pebble gravel;
b) clay and silt; and
c) bleach and shallow water, and sand gravel.

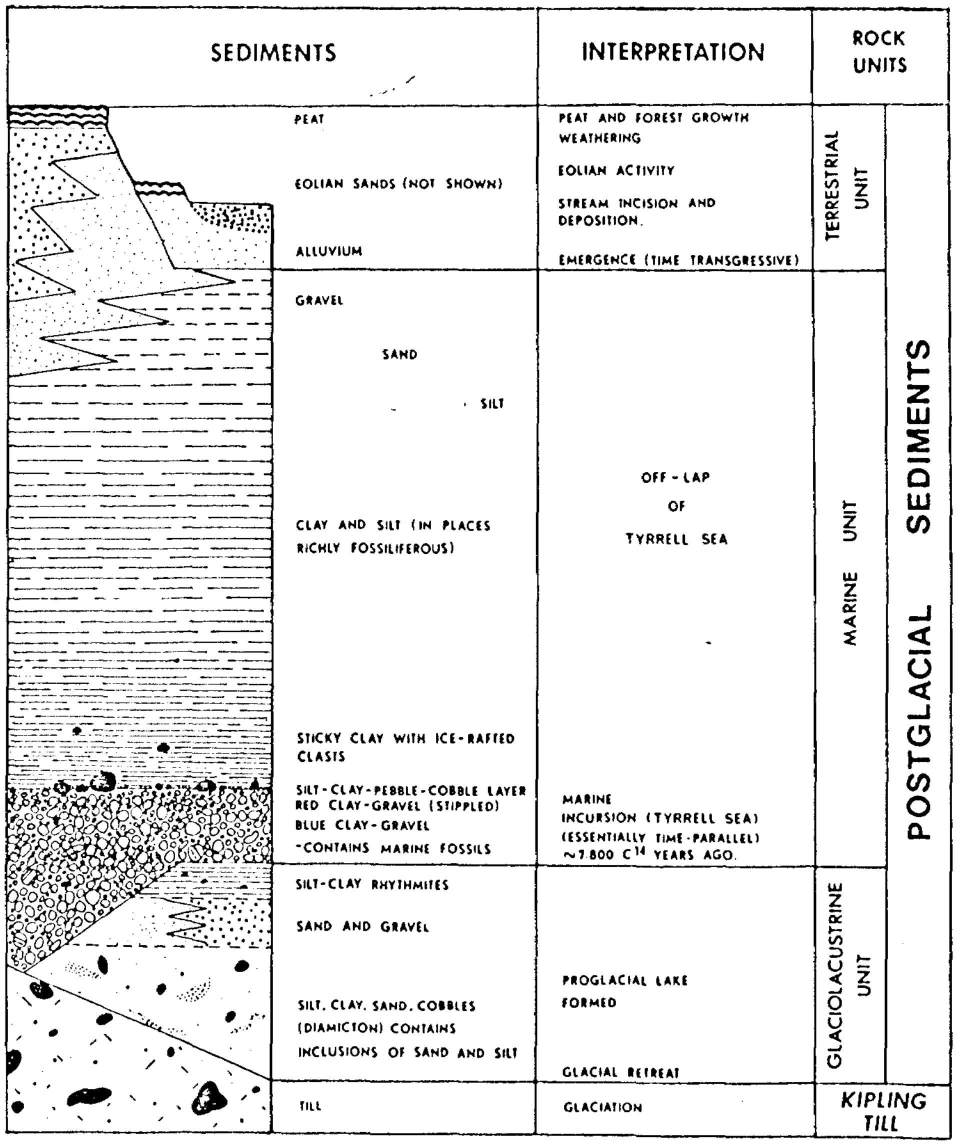


FIGURE : Hypothetical composite late- and postglacial section.
(from Skinner 1973)

The oldest of the sediments is the clay-pebble gravel; the clay, silt, sand and gravel are younger lateral facies equivalents (see Figure).

Fossils are indigenous to the entire marine unit, although they tend to occur more frequently in silt and sand. During the 1982 field season, the presence of marine clays was inferred from the appearance of shell fragments as well as the calcareous nature of the sediments.

The lateral facies equivalents were deposited in bay, mud flat, beach and river mouth-bar environments associated with the off-lap of the Tyrell Sea. Large volumes of sand and gravel, as observed in Hole ONEX-82-09, are suggestive of a beach depositional environment, especially near the marine limit, close to where the major rivers drained into the sea.

The origin of the widespread basal clay pebble conglomerate may be attributed to the occurrence of strongly erosive underflow currents that were produced when the Tyrell Sea breached the remnant ice sheet in the Hudson Bay Basin. Marine clays, which overlie the clay–pebble gravel, indicate a return to the quiet bottom conditions that prevailed prior to the influx of the saline water. Drillholes ONEX-82-01, ONEX-82-04, ONEX-82-07, ONEX-82-11, ONEX-82-12, ONEX-82-17, and ONEX-82-18 all contain the fossiliferous clays of the marine unit. The terrestrial unit constitutes the uppermost sediments of the recent deposits. The terrestrial unit is representative of a transgressive period characterized by various geological events (activities?) such as stream weathering and peat and forest growth (see Figure).

The sediments of the terrestrial deposits, include peat, alluvium, and aeolian sand. Each of the 18 holes drilled in the 1982 field program penetrated the peat which blankets most of the Moose River Basin. However, there was little evidence to indicate that intersections with either aeolian or alluvium deposits occurred in any of the drillholes. General comments on the economic potential of the peatlands in the James Bay Lowland are included in Section 7.7.

6.2 PLEISTOCENE

In his examination of the Quaternary stratigraphy of the Moose River Basin, Skinner recognized five till sheets separated by both organic and inorganic nonglacial sediments. The sequence he identified consists of three tills of pre-Wisconsin age overlain successively by the Missinaibi, formation of probable Sangomon age, the Adam Till, Friday Creek interglacial sediments, and the uppermost Kipling Till (see ~~Figure~~ Table 6).

The various units Skinner outlined are largely based on the stratigraphic position relative to two marker beds:

1) interglacial peaty sediments; and
2) postglacial basal marine clay-pebble gravel.

The parameters that Skinner used to differentiate the tills are mean grain size (Mz) and percent total carbonate (%(CO_3)). During the 1982 field season, no real effort was made to discriminate between the various tills since accurate laboratory analysis was not available.

The oldest of the Quaternary sediments comprise at least three tills separated by silt and clay rhythmites, sand and gravel. The paleocurrent direction trends southward indicating that natural drainage to the north was inhibited. Furthermore, no evidence from paleocurrent data, marine deposits, or weathering was available to suggest the withdrawal of ice from Hudson Bay during either retreat interval. Rather the intertill sediments have been interpreted as having a glaciolacustrine origin. Diamicton lenses within the intertill sediments are derived from nearby ice, perhaps as local flow tills.

Within the pre-Missinaibi tills, siderite occurs as reddish-brown euhedral, single tabular and composite crystals (roses) and as massive-grained, globular and earth masses, commonly attached to or enclosing quartz grains. Siderite envelopes quartz grains to the exclusion of other minerals; therefore, the siderite was probably reworked rather than formed as a primary mineral within the till.

TABLE 6

QUATERNARY ROCK-STRATIGRAPHIC UNITS AND INFERRED EVENTS, MOOSE RIVER BASIN FROM SKINNER (1973)

ROCK-STRATIGRAPHIC UNIT	INFERRED EVENT	AGE C^{14} years B.P.
	weathering; peat and forest growth	
Terrestrial unit	eolian activity	
	stream incision and deposition	
Marine unit	marine recession	
	marine incursion	7, 800
Glaciolacustrine unit	glacial retreat	
KIPLING TILL	glacial advance	
Friday Creek sediments	retreat	
ADAM TILL	glacial advance	
MISSINAIBI FORMATION: Lacustrine member	lacustrine transgression	
MISSINAIBI FORMATION: Forest-peat member (buried soil)	weathering; peat and forest growth	>54, 000
MISSINAIBI FORMATION: Fluvial member	stream incision and deposition	
MISSINAIBI FORMATION: Marine member	marine recession	
	marine incursion	
	glacial retreat	
TILL III	advance (glaciation)	
Intertill sediments II-III	retreat (glaciation)	
TILL II	advance (glaciation)	
Intertill sediments I-II	retreat (glaciation)	
TILL I	advance (glaciation)	

The presence of Quaternary marine shells in the pre-Missinaibi tills indicates that the James Bay Basin was occupied by marine waters prior to the Missinaibi interval.

The Missinaibi Formation marks the occurrence of a intersade or interglaciation during which four types of nonglacial sediments were deposited in response to the events of this period. The Missinaibi beds and related nonglacial sediments may be divided into four members:

a) marine,
b) fluvial,
c) forest-peat, and
d) locustrine.

The geological events that are responsible for the sequence of Missinaibi sediments include:

1) Incursion of the Bell Sea to an altitude at least 100 m above present sea level.

2) Recession of the Bell Sea to a level near the present sea level. During this emergent interval, rivers flowed north to the sea, incising alluvial terraces in the surrounding region. Subsequently, soil formed on fluvial deposits, till and aerially exposed marine sediments, and supported the growth of hydrophytic vegetation. As the end of the nonglacial period approached, a large lake flooded the land. These late lacustrine deposits mantled the earlier sediments of the Missinaibi Formation and eventually were overriden by the advancing glacier.

Overlying the lacustrine member of the Missinaibi Formation, from bottom to top, are:

1) Adam Hill,
2) Friday Creek sediments, and
3) Kipling Till.

The Adam Till is clayey, greenish-grey and contains a few large boulders. Identification of the Adam Till is based primarily on its stratigraphic position immediately above the Missinaibi Formation. The lacustrine member may be incorporated into the overlying Adam Till. The fine texture, green colour, and low carbonate content typical of the till appears to have been acquired from the lacustrine beds.

Ice-flow direction indicators for the Adam Till suggest that the ice flowed from the northeast, possibly from Labrador.

Separating the Adam and Kipling Tills are the Friday Creek nonglacial sediments. The unit consits of loose, medium- to fine-grained cross-stratified sand, and rhythmites. The rhythmites may exhibit climbing ripple lamination (south-flowing current) at some location. Unfortunately minor structural features cannot be recognized when reverse circulation drilling techniques are practiced and, therefore, we have little data on these units as a result of the 1981 and 1982 drill programs.

The structural features, preserved in the Friday Creek sediments indicate a former current to the south, against the regional gradient. Moreover, the ice sheet appears to have blocked drainage to the north resulting in the deposition of Friday Creek sediments by glacial meltwater. Since no datable organic material is available from these nonglacial sediments, age determination of the interval of deposition is not currently possible.

The youngest till of Pleistocene age is the Kipling Till. A combination of parameters is used to distiguish the Kipling Till from other Pleistocene Tills, including low compaction, brownish colour, and its stratigraphic position as the youngest and uppermost till in the region. Texture and carbonate content are not diagnostic; however, the Kipling Till tends to be more calcareous than the older tills.

Locally directions of ice flow within the Kipling Till are determined by examining exposures of the boulder pavement at the base of the till. The inferred direction of flow is southward.

The 1982 drillhole that demostrates the greatest volume of Pleistocene sediments is ONEX-82-16, with a thickness of at least 425 feet (130 m). Pleistocene deposits are of interest when sampling because the basement debris contained in the till is a good indicator of Precambrian lithology. Unfortunately, in several holes it was not possible to penetrate the entire Pleistocene section due to the limit on depth imposed by reverse circulation drilling.

6.3 CRETACEOUS

The Cretaceous sediments in the Moose River Basin consist only of the Mattagami Formation, a term coined by Dyer to refer to the unconsolidated Mesozoic beds in the region. Dating of the sediments, through analysis of pollen and spores, indicates that the deposit is of early and middle Albian age (late Early Cretaceous); therefore, it may be inferred from its occurrence in the Early Cretaceous that unconformities exist both at the base and the surface of the Mattagami Formation.

The lithologic Cretaceous sediments has proven to be extremely variable; the Mattagami Formation comprises varicoloured clays and silts, white quartzitic sands, and occasional lignite seams. Two facies associations have been identified within the Cretaceous deposits of the Moose River Basin: an upper member consisting of thick sequences of white interbedded quartzose sand, white kaolinitic or variegated clays; and a lower member characterized by dark grey, or black clays commonly with abundant carbonaceous material and minor sandy intervals. The lower section grades into a dark green to grey clay at the base, which may be transitional into the topmost Long Rapids Formation.

Occurrences of all potentially economic commodities within the Mattagami Formations are summarized in Tables 8 , 11 , and 12 in Chapter 7. Moreover, a brief description of the nature of each occurrence is included in the tables, and any associated minerals and sediments (such as iron sulphides) are identified.

The Cretaceous sediments in the region, although generally present at depth, are discontinuous throughout the Moose River Basin. The presence of discontinuities within the Cretaceous is attributed to: hypothetical subsurface ridges in the Archean basement; ridges in the Devonian; and removal of the Cretaceous by gouging ice sheets or by river erosion in the Late Cretaceous or Cenozoic. The absence of the Cretaceous where the Pleistocene is relatively shallow, as in ONEX-82 — indicates can extension of the nearby pre-Cretaceous arch at Grand Rapids.

During the 1982 field program available core and drill logs were examined by D. Long in an effort to develop a workable sedimentary model for the Moose River Basin. Long proposed that coals with abundant woody material are associated with distal splay deposits emanating from high-constructive streams. The features of high-constructive river systems include high channel stability due to extensive vegetation in the river banks, high rate of vertical accretion, and high ratio of floodlain to level and channel deposits.

The presence of two types of channel sands in ONEX-82-14, stable channel (vertical stacking) and unstable channel (meandering) system, indicate that the Cretaceous fluvial system was of intermediate or mixed type. Long recommends that further drilling be encouraged to delineate channel systems, with emphasis placed upon locating the thick coals associated with the channel margins of high-constructive streams.

An interesting karst feature, indigenous to the Cretaceous, is the presence of solution collapse breccias. As dissolution occurred in the Middle Devonian limestones, the overlying sediments infilled the cavities. D. Long recognized karst features in drillholes ONEX-82-02, ONEX-82-03, ONEX-82-04, and ONEX-82-07. The presence of lignite chips within the karst fill of Hole ONEX-82-07 indicates that solution collapse breccias must have developed in the Cretaceous. Information concerning the lithological characteristics and the extent of the Mistuskwia beds is restricted to data obtained from the 1975 ODM holes.

6.4 JURASSIC

Located in the central part of the Moose River Basin and extending no farther south than the Grand Rapids Arch complex, are the Middle Jurassic sediments that comprise the Mistuskwia beds. These sediments consist of unindurated quartzose sands and clays, which may be distinguished by their age (through palynological analysis) and petrology.

The Mistuskwia beds are separated from the overlying Mattagami Formation by an unconformity spanning 60 to 70 million years. Despite the magnitude of the hiatus, placing the contacts between Cretaceous and Jurassic sediments has been tenative due to similarities in the lithology of each formation.

The Mistuskwia beds were identified in ODM Holes 75-2 and 75-3 in the western part of the basin. The quartz sands from the base of these holes are texturally more mature (good sorting, well rounded, high sphericity) that the Cretaceous sands, and have a very calcareous matrix. Furthermore, Hamblin (1976) suggested that the Mistuskwia beds may be second cycle sediments with a provenance in the northwest.

To-date, none of the OEC-81 or ONEX-82 holes have indicated the presence of Jurassic sediments.

6.5 PALEOZOIC

Two formations comprise the Devonian sediments in the Moose River Basin: the Upper Devonian Long Rapid Formation and the Middle Devonian Williams Island Formation.

The Long Rapids in the Moose River Basin consists mainly of dark shales, siltstones and clays, interbedded with grey-green and chocolate coloured mudstones and clays, as well as minor bands of limestone and dolomite. The dark brownish-black to grey shales contain pyrite and occasional iron nodules.

The Long Rapids Formation is of potential economic importance as a source of oil shale. The probable areal extent of the formation is given in Figure 15 . Although the total thickness of the formation is not known, estimates in excess of 90 m have been ascribed to the Upper Devonian deposit of the Moose River Basin.

According to a study of Onakawana Drillhole A by Dyer and Crozier (1933), the Long Rapids may be subdivided into three informal lithologic members:

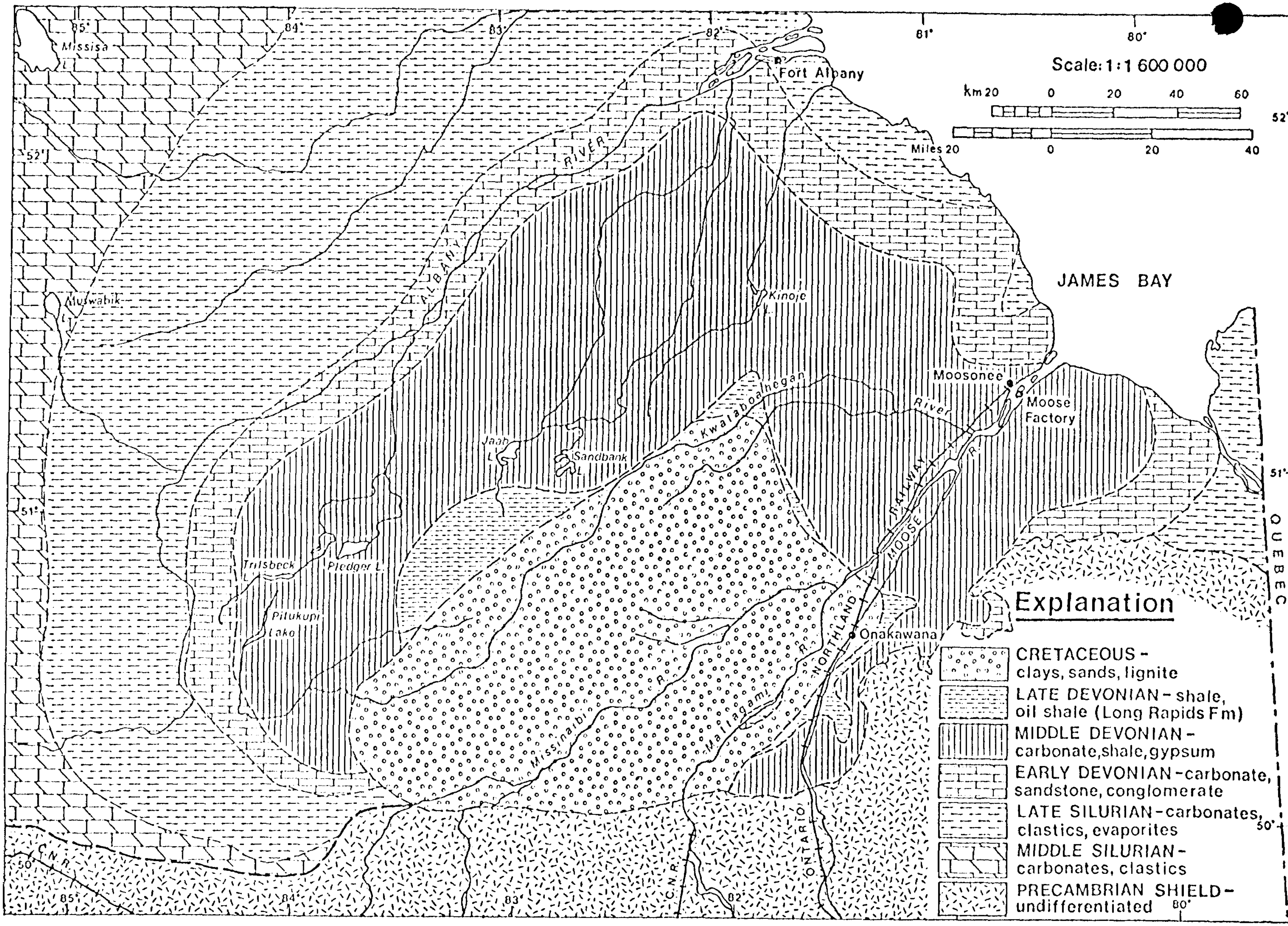


FIGURE [illegible]: General geology of the Moose River Basin.

Member	Thickness at Onakawana (feet)	Lithology
Upper Member	68	Interbedded greenish-grey clays and clay shale.
Middle Member	97	Dark bituminous shale with thin bands of greenish-grey clay.
Lower Member	120	Pale greenish-grey clay to grey shaly clay with bands of dark bituminous shale and hard concretionary material.

Long Rapid Formation were obtained in ONEX-82-01, ONEX-82-04, ONEX-82-05, ONEX-82-06, and ONEX-82-11. Palynological studies of some of the Devonian core from 1981 drillholes discovered assemblages of spores and microplankton consistent with a Late Devonian (Frasnian–Famenian) age.

Underlying the Long Rapids Formation are the Middle Devonian limestones and calcareous shales that represent the Williams Island Formation. The limestones are oolitic, fossiliferous (biosparites and biomicrites are present) and in places argillaceous. The Williams Island shales are bluish-grey in colour and calcareous, unlike the younger dark grey to black bituminous shales in the Upper Devonian.

In the 1982 drilling program, the Williams Island Formation was intersected in ONEX-82-02 at 280 feet, ONEX-82-03 at 275 feet, and ONEX-82-06 at 441 feet. Moreover, the formation was encountered as angular blocks or fragments in the Cretaceous solution collapse breccias in ONEX-82-02, ONEX-82-03, ONEX-82-04, and ONEX-82-07.

6.6 PRECAMBRIAN

The Moose River Basin is bounded by the Precambrian escarpment along part of its southern margin, indicating that the region has undergone extensive faulting and uplift to accommodate this particular geological setting. Faulting occurs along two main strike trends — north to northwest and northeast, respectively. The fault origin of the subsurface scarp may be inferred from the truncation of the rocks of Ordovician, Silurian, and Devonian.

The oldest known rocks in the area are metavolcanic and metasedimentary rocks of Archean age. Within these units are numerous intrusions, mostly granitic, with mafic and diabase dykes occurring to a somewhat lesser extent. Large airborne magnetic anomalies suggest that the Precambrian may be of interest as a source of other commodities. Of even greater interest is the presence of diamonds; these have been seen in outcrop at Coral and Sextant Rapids on the Abitibi River. Furthermore, the presence of an associated mineral, pyrope, was discovered in the Cretaceous sands of ONEX-82-03. Hopefully, sample analysis of the sediments will reveal further showings of associated minerals so that a possible source area may be determined.

7. ECONOMIC GEOLOGY

7.1 INTRODUCTION

Previous reports by WGM (1981, 1982), as well as by Rodgers et. al. (1975), Telford and Verma (1978), Telford (1979), and Guillet (1979), have reviewed various aspects of the economic geology of the James Bay Lowland area. Table 6 summarizes the various commodities of potential economic interest in the region. This section of the report discusses, in detail, the results of the 1982 summer drill program in the licence area.

The aims of the 1982 program were:

a) To drill several holes in the vicinity of the 1981 lignite discovery in Gentles Township to better define this discovery.

b) To drill several widely spaced holes, largely in the central and western portion of the licence area, to evaluate areas where no previous work had been done as well as to fill in areas where limited information from previous work had not indicated significant lignite reserves. Should the additional work prove discouraging, then these regions could safely be dropped from the licence area in order to limit future exploration expenditure requirements.

c) In the course of drilling Pleistocene and Cretaceous clastic sediments, samples were to be taken systematically and the heavy minerals concentrated and examined optically. This was recommended as the best procedure in evaluating the possible presence of buried kimberlites (diamonds), plus a variety of base and precious metals and uranium. In addition, natural gamma wireline geophysical logging was done to reveal the presence of any significant concentrations of radioactive minerals.

d) To carefully log, and in most cases sample, any Cretaceous silica sand (with or without clay) and clay units encountered during the drilling. Sample material was then to be tested for its potential use for a variety of industrial needs.

e) To drill selected holes into the Long Rapids Formation to evaluate the oil shale potential of this unit. In addition, surface sampling of the Long Rapids Formation in the immediate vicinity of Williams Island was planned in order to better evaluate results obtained by previous work.

7.2 LIGNITE

7.2.1 GENERAL OCCURRENCES AND NEW DISCOVERIES

The major and minor lignite occurrences in the James Bay Lowland are located in Map I (map pocket). The major occurrences are tabulated and briefly described in Table 6. All occurrences encountered in the 1982 program are summarized in Table 7.

The Onakawana lignite deposit has been described in many previous reports, of which one of the more recent and complete reports is that by Price (1978). The deposit has been drilled exhaustively (at least 300 holes) over the years, and its reserves are estimated to be approximately 200 million tons. The lignite occurs in two principal seams: the lower seam has an average thickness of 4.2 m (14 feet), but is as thick as 6 m (20 feet) in places; the upper seam averages 5.4 m (18 feet). The two seams are separated by a clay unit that thins laterally in places so that the two seams merge. The deposit as a whole covers only about 40 km^2. Lateral variations are quite abrupt; rapid lateral variations in seams may be a typical feature of other major lignite occurrences in this Cretaceous Basin.

The first major new lignite discovery in the James Bay Lowland was made in 1978 by a drill program sponsored by the Ontario Ministry of Northern Affairs and managed by Gartner Lee Associates Limited. As reported by Guillet (1979), this discovery is located in the southwest quarter of Sanborn Township, 22 km north-northwest of Smoky Falls. This discovery is on the mineral exploration licence area issued to Lignasco in 1980. This important discovery consists mainly of one 20 feet thick seam of earthy lignite (Figure 19). Since the drilling was done by reverse-circulation, it is difficult to tell whether there are any significant clay interbeds. The unavailability of any borehole geophysical data also makes it difficult to tell whether the entire seam is massive or not. The available test data indicate high ash contents in several samples.

It is our understanding that, through an agreement with Selco Ltd., several holes have been drilled in the general vicinity of the Sanborn discovery; but we are unaware of any results. Despite the fact that previous drilling in nearby areas had generally

FIGURE : Grand Rapids on the Mattagami River. The rapids are an expression of the broad regional Grand Rapids Arch. See text for discussion.

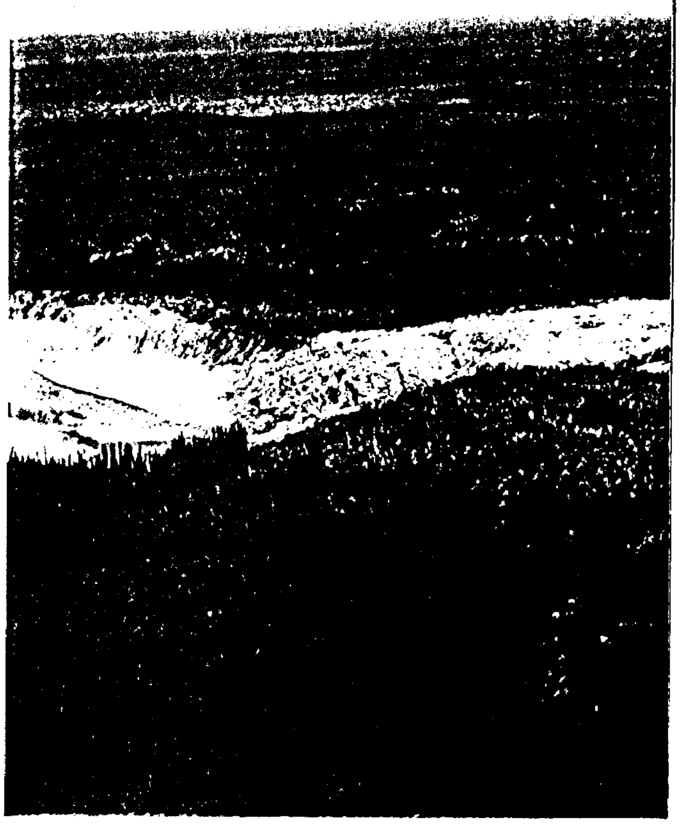


FIGURE : Looking east across Adams Creek. The solid bedrock is Precambrian basement that is in fault contact with unconsolidated Cretaceous sediments exposed in the river banks (left side of photo)!

TABLE 1

POSSIBLE ECONOMIC COMMODITIES IN THE JAMES BAY LOWLAND

COMMODITY	MAIN OCCURRENCES	GEOLOGICAL ASSOCIATION	COMMENTS
Lignite	Onakawana Sanborn Township (1978 discovery by the MNR) Gentles Township (1981 discovery by the OEC) West Gentles Township (1982 discovery by ONEXCO) McBrien Township (1982 discovery by ONEXCO)	Most known occurrences appear to be associated with fluviatile, non-marine sequences of late Early Cretaceous (Albian) age: probably formed along banks of major tributaries and in swamplands between river channels.	Recent discoveries confirm very significant regional tonnage potential. More drilling required to better define regional potential as well as extent of new discoveries.
Oil Shale	Extensive occurrences near the Abitibi and Mattagami Rivers.	Upper Devonian Long Rapids Formation.	The best occurrences appear to be in the vicinity of Williams Island.
Clay	Known virtually everywhere that Cretaceous sediments occur.	Mattagami Formation: frequently in silica sands, but also as discreet beds.	Abundant kaolin: vast reserves of impure clays, but great potential for high-quality products.
Silica Sand	Known virtually everywhere that Cretaceous sediments occur.	Mattagami Formation.	Great variety of quite pure sands that are suitable for a great variety of industrial needs.
Mica	Associated with some Cretaceous sands.	Mattagami Formation: usually as a coarse and/or fine accessory mineral in silica sands.	Apparently not very widespread, but little is known of extent: possible industrial use.
Diamonds	No occurrences authenticated: kimberlite-like exposures and pyrope trace minerals known in the area.	Kimberlites are post-Late Devonian and apparently pre-Aptian in age.	The small size and widespread cover makes exploration for the kimberlite very difficult.
Gypsum	Widespread exposures in the general vicinity of Moose River.	Associated with a sequence of Middle Devonian marine sediments belonging to the Moose River Formation.	Large tonnages near surface and near railway: could be a significant resource of the future.
Limestone	Limestone cliffs near Grand Rapids (Mattagami River) and Coral Rapids (Abitibi River): many other known occurrences as well.	A variety of limestones occur within various members of Middle and Late Devonian marine sediments.	Could be of real economic significance if lignite deposits are exploited.
Peat	Covers virtually the entire James Bay Lowland.	These Recent deposits are generally less than 6' thick, but very extensive laterally.	Draining not necessarily a problem: could be of great economic significance if other commodities were exploited.
Metals	None known although a large columbium-bearing carbonatite occurs east of the area.	A variety of precious, base, and strategic minerals could occur in the Precambrian basement rocks: some base metals could be associated with Devonian carbonates.	Very difficult to explore for because of extensive cover.
Sulphur	The lignite contains minor native sulphur, but iron sulphide is abundant in the lignite and in the Devonian oil shales.	Mostly in the form of pyrite associated with the Cretaceous lignites and Long Rapids Formation shales.	If the lignite and/or oil shale was exploited, then sulphur could be an important byproduct.

TABLE 8

LIGNITE OCCURRENCES

HOLE NUMBER	FROM–TO	THICKNESS	COMMENTS
5	273.5–238.0	0.5	Lignite occurs with wood chips in carbonaceous clay over a 66.5' interval (235.5–302.0'). Minor very fine-grained sand seams appear intermittently throughout sequence. Lignite has a vitreous lustre and is also pyritiferous.
	246.0–268.0	22	
	279.5–282.0	2.5	
	287.0–295.0	8	
6	188.0–189.5	1.5	Lignite is integrated in a sequence of fine-grained silica sand seams and carbonaceous clays.
	207.0–214.0	7	
	214.5–221.0	6.5	
8	299.0–299.5	0.5	Lignite chips comprise 90% of silica sand.
	304.0–326.5	22.5	Pyritiferous lignite occurring in a carbonaceous clay with a very minor sandy component.
	334.0–343.0	9	As above.
	385.5–386.5	1	Lignite chips and pyrite blebs within a coarse-grained silica sand.
	413.5–416.0	2.5	Pyritiferous lignite in a dark grey/black claystone, rich in detrital lignite. Very minor amount of fine-grained sand imparts a gritty texture to lignite.
	130.5–137.0	6.5	Abundant lignite chips up to ¼" long in variegated clays.
14	424.0–424.5	0.5	Small lignite seam occurs in a sandy clay rich in both lignite and muscovite.
	445.0–446.5	1.5	Lignite seam appears in a carbonaceous clay from 442.3–452.0'.
	461.7–465.2	3.5	Mostly fragmental lignite with considerable clay and quartz grains; minor FeS_2 and elemental sulphur.
	467.2–469.0	1.8	As above.
	473.3–480.0	6.7	As above but with more clay as thin bands and intermixed. Grades down into a carbonaceous clay.
	488.5–492.0	3.5	As above.
	495.0–500.0	5	Lignite with abundant carbonaceous clay.
	501.0–519.0	18	Fragmental lignite with considerable clay. Very minor FeS_2 and possibly some elemental sulphur.
	520.0–524.0	4	As above.
15	283.0–283.5	0.5	Large lignite chips comprise >50% of sample in a silica sand interval.

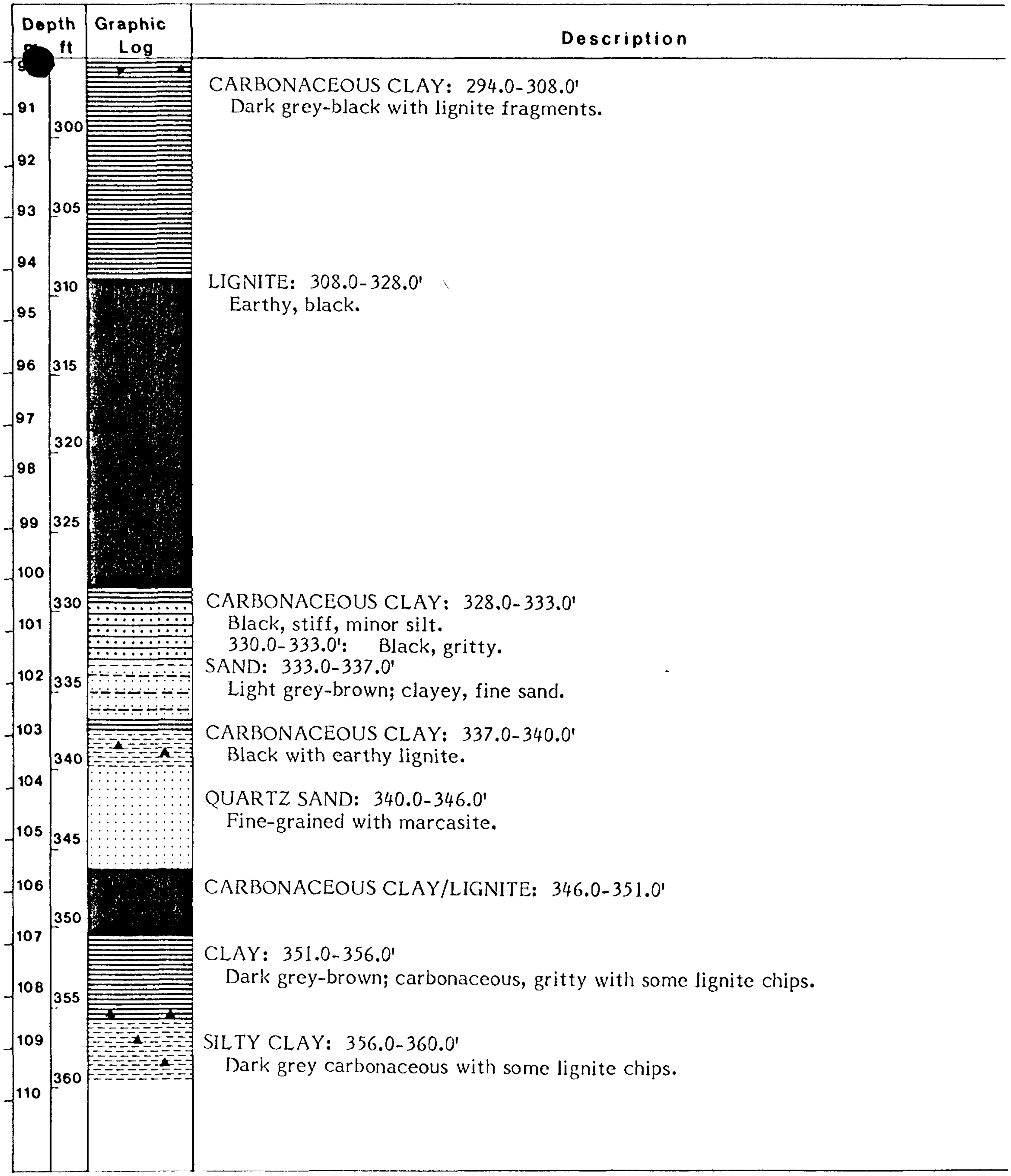


Figure: 18 Descriptive log of the main Sanborn Twp. lignite intersection. Taken from drill log 78-06 in report Guillet, 1979.

It is our understanding, that through an agreement with Selco Ltd., several holes have been drilled in the general vicinity of the Sanborn discovery but we are unaware of any results. Despite the fact that previous drilling in nearby areas had generally negative results, there is a lot of acreage in the immediate vicinity of the discovery hole and extensive reservers may be possible, especially in the area between the main lignite seam and drillholes 78-01 and 78-02 near Adam Creek. Although Hole 78-02 had only minor lignite, drillhole 78-01 contained at least ten thin lignite seams (0.4 to 2.7 m thick) between depths of 65 to 125 m.

As far as we can tell very little actual drilling has been done to better define the Sanborn lignite discovery. However, some considerable publicity has been given to ideas by a senior Lignasco official who thinks that this discovery may be amenable to an in-site gasification scheme. Certainly the considerable depths that the Sanborn lignite occurs at (308–328 feet: 94–100 m) precludes a conventional mining system.

The 1981 discovery in Gentles Township by OEC was discussed at length in the Summary Report on the 1981 Exploration Program in the James Bay Lowland by Watts, Griffis and McOuat Limited. This discovery is illustrated in Figure 19. It consists of close to 20 feet (approximately 6 m) of lignite although the upper section of the seam appears to contain a thin clay parting(s) that is probably about 2 feet (approximately 4 m) thick. Uncontaminated samples of the lignite have yielded quite high calorific values (dry basis) but the ash content is generally high (15–30% on a dry basis). Interestingly, the sulphur content is also quite high (2–8 wt%: dry basis): most of this sulphur is in the form of fine-grained, but clearly visible, iron sulphide.

The 1982 drill exploration program by Onexco Minerals Ltd. was partly designed to broadly outline the extent of the 1981 East Gentles Township discovery. Figure 20 gives the locations of the drillholes in this vicinity. Of the seven holes drilled near this discovery, only two holes intersected significant lignite. The lignite in hole ONEX-82-05 is illustrated in Figure 21, whereas Figure 22 illustrates the lignite discovered in drillhole 82-06. Hole ONEX-82-05 contains one main seam (up to 23 feet thick) that was cored. The core contains minir, irregular but persistent clay partings and in places abundant pyrite. The main seam is at a depth of 245–268 feet and atherefore modestly deeper than the seam discovered in drillhole OEC-81-12. In

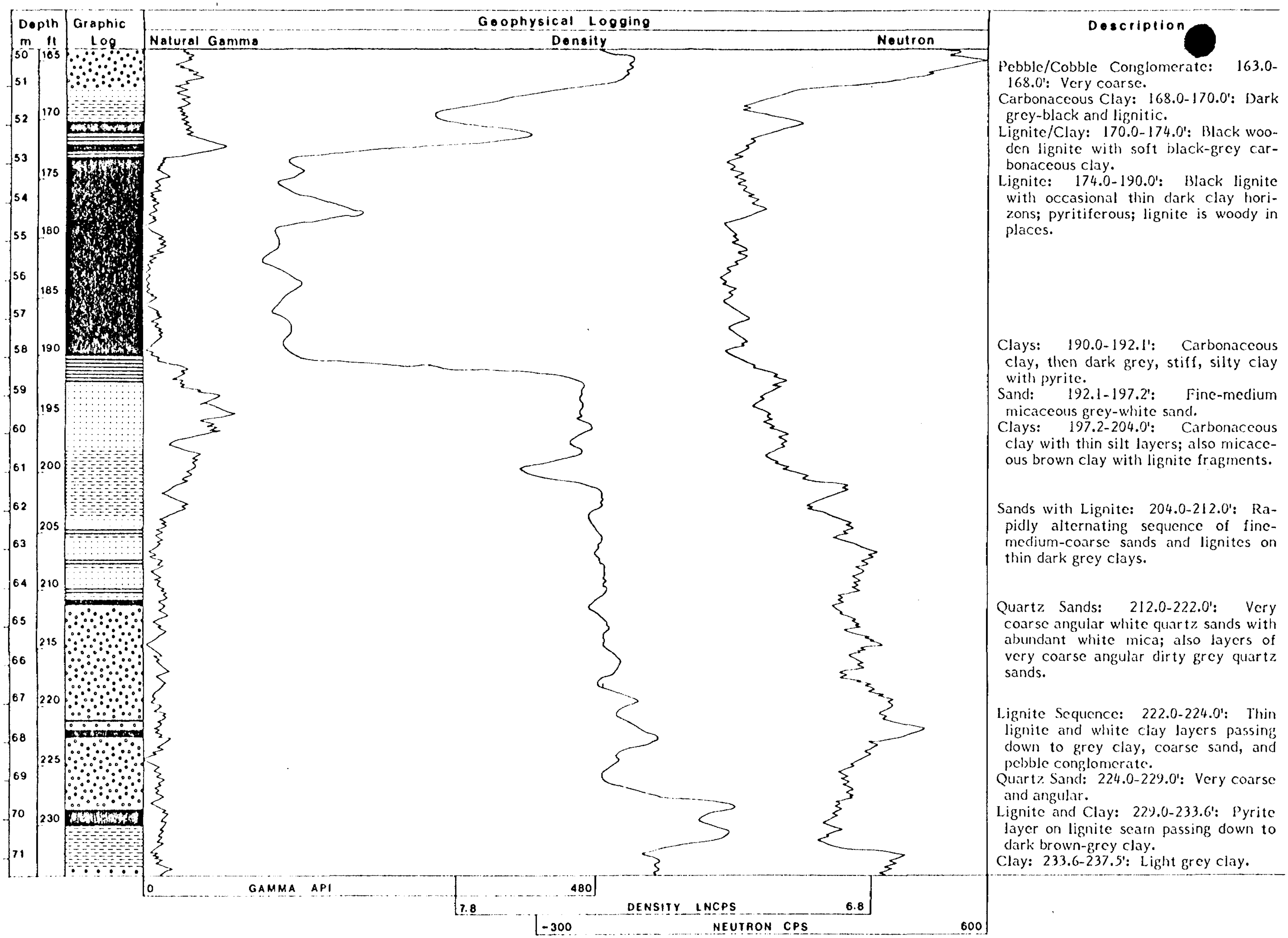


Figure: East Gentles Twp. lignite occurence. Geological and geophysical log of part of drill hole OEC-81-12

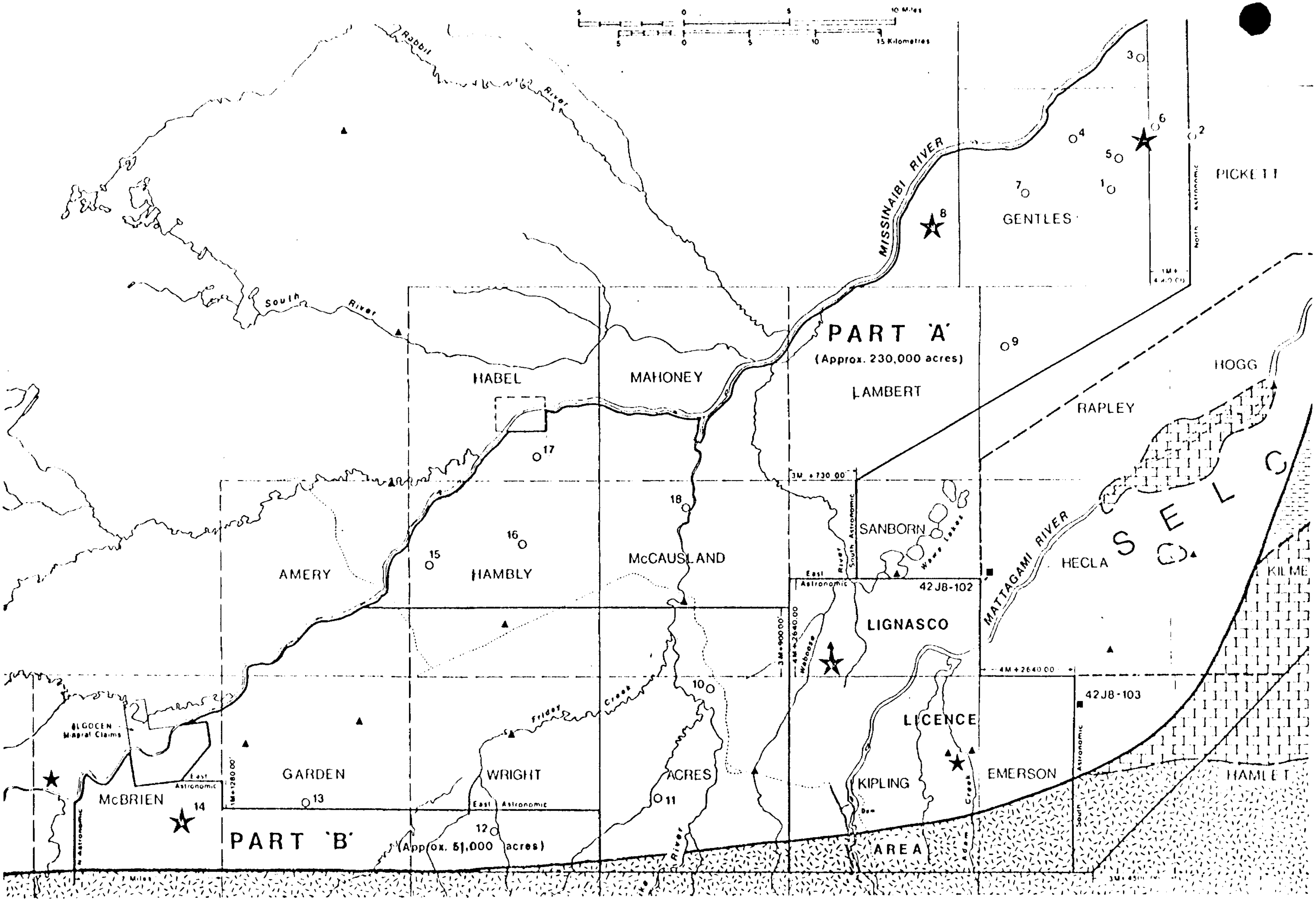
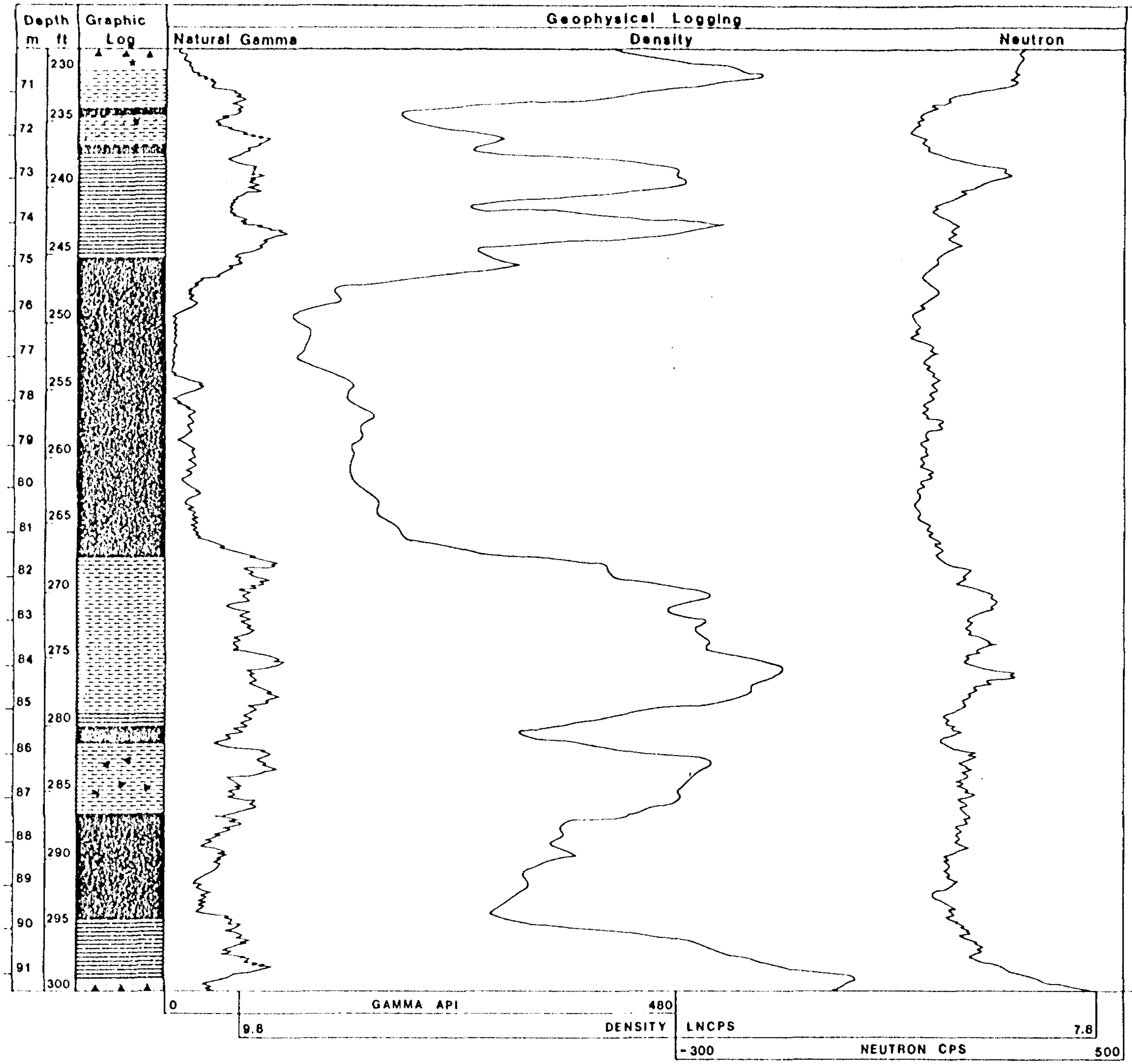


FIGURE 20: General location of lignite occurrences.



Description

Silica Sand: 228.0-232.0': Very fine-grained micaceous sand with thin lignite seams(?) and pyrite blebs.

Clay: 232.0-234.0': Grey-brown slightly gritty clay.

Lignite: 234.0-235.0': Grades into carbonaceous clay.

Silica Sand: 235.0-235.5': Contains trace lignite.

Clay: 235.5-237.0': Brown sandy clay with carbonaceous clay/lignite.

Silica Sand: 237.0-237.5': Contains trace lignite.

Lignite: 237.5-238.0'.

Carbonaceous Clay: 238.0-246.0': Dark brown-black clay containing lignite and dark brown woody chips.

Lignite: 246.0-268.0': Pyritiferous.

Clay: 268.0-279.5': Medium grey and beige, stiff, micaceous.

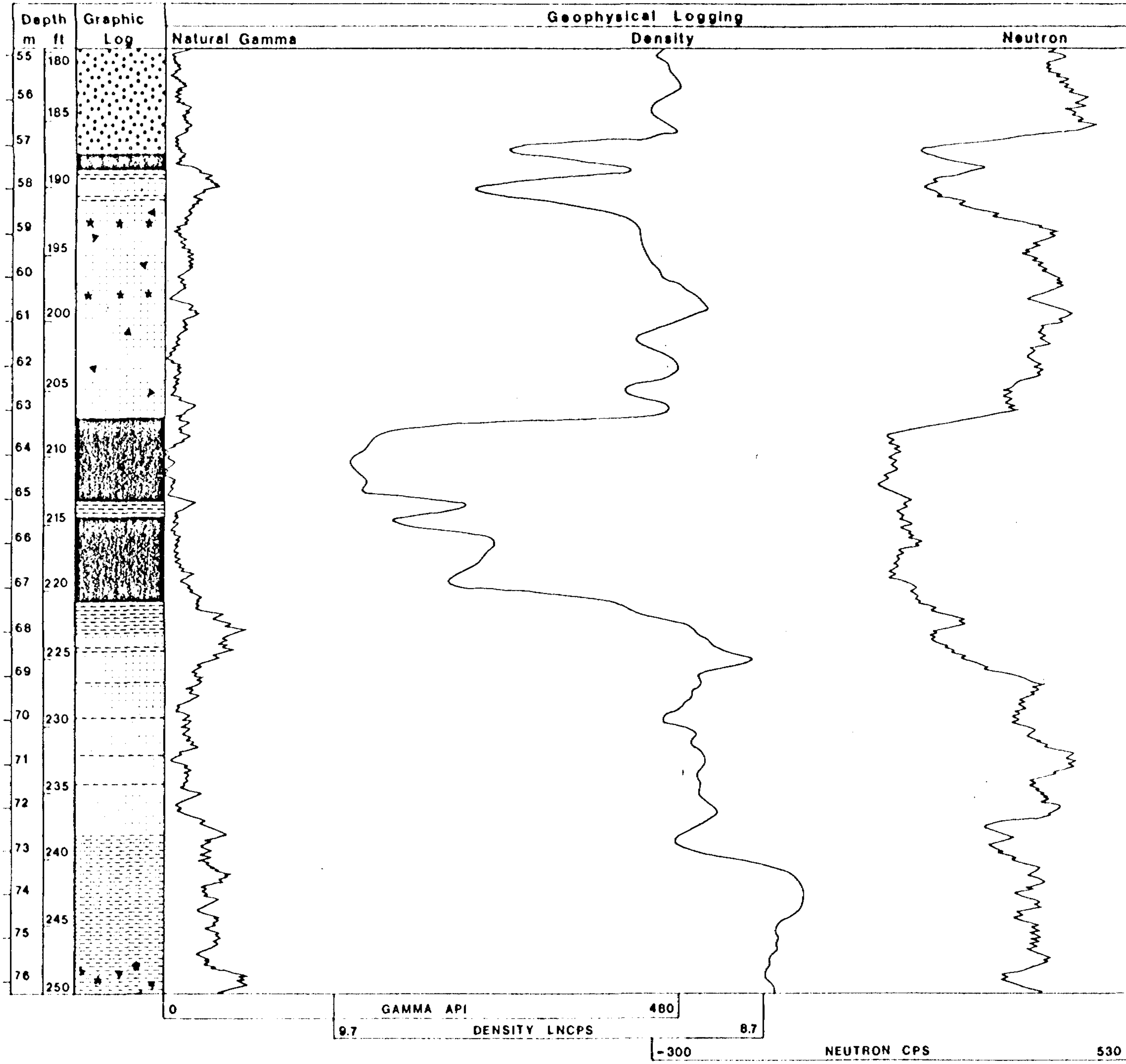
Lignite/Carbonaceous Clay: 279.5-282.0'.

Clay: 282.0-287.0': Dark grey with lignite chips.

Lignite: 287.0-295.0': Pyritiferous; few dark brown woody sections.

Carbonaceous Clay: 295.0-299.0': Contains abundant lignite chips; clay has woody texture.

Figure: East Gentles Twp. lignite occurence. Geological and geophysical log of part of drill hole ONEX-82-05



Description

Sand/Pebbles: 181.0-188.0': Medium-grained sand with 10-15% pebbles.

Lignite: 188.0-189.5'.
Clay: 189.5-190.5': Micaceous.
Carbonaceous Clay: 190.5-191.0'.
Sand: 191.0-207.0': Fine-grained sand with minor lignite and several thin pyrite layers.

Lignite/Carbonaceous Clay: 207.0-222.0': Minor pyrite.

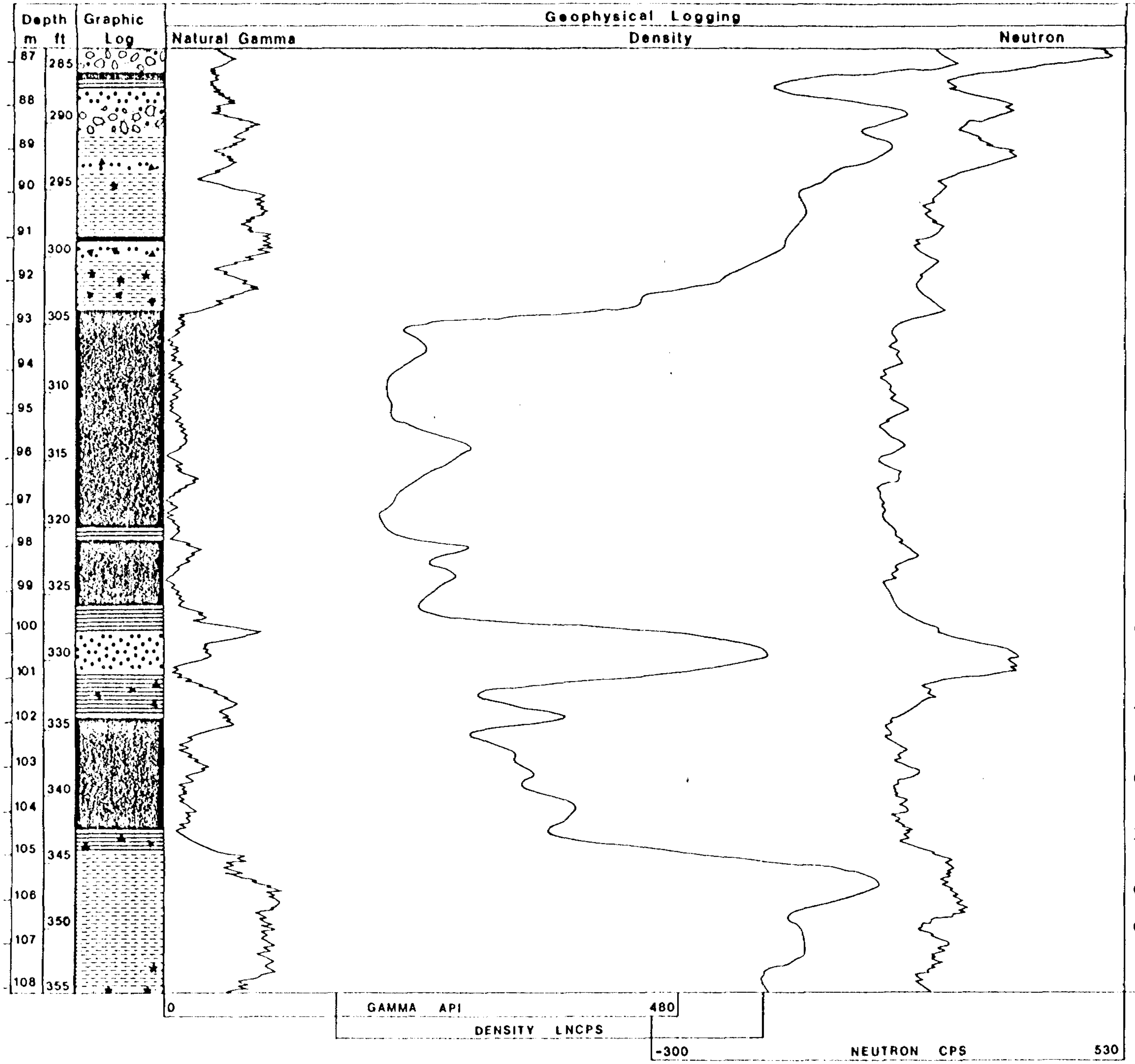
Clay/Sand/Gravel: 222.0-241.0': Tan-medium grey clay, pyritiferous; few lignite chips; fine to coarse sand with occasional buff-coloured clay layer.

Clay: 241.0-251.5': Light brown gritty clay; micaceous; abundant brown lignite chips and pyrite blebs at 248.0-251.5'.

Figure: 22 East Gentles Twp. lignite occurence Geological and geophysical log of part of drill hole ONEX-82-06 addition, there is another significant (approximately 8 feet) seam in drillhole 82-05 at depths of 287–295 feet. On the other hand, drillhole ONEX-82-06 located just north of the 1981 discovery hole had only a 14–15-foot seam (includes a 1-foot clay parting) at depths of 207–222 feet. Despite the thickness and depth differences, we think these seams are probably correlative. There appears to be sufficient untested areas northwest and southeast of these three holes to provide considerable tonnage potential.

The first new major discovery in the 1982 drill program was west of Gentles Township, near the Missinaibi River (see Figure 20). Drillhole ONEX-82-08 penetrated two main lignite seam, the thickest (22.5 feet) of which occurs at a depth of 304–326.5 feet (includes 0.5–1.0 feet clay parting). The second, deeper seam is considerably thinner (9 feet), but nevertheless quite significant. This intersection was penetrated by reverse circulation and therefore detailed features are not well-known. However, the geophysical logs indicate a probable high clay content in the lignite. This hole is virtually open in all directions: the closest hole (82-07) is about 7.5 km away and the possibility of developing significant reserves must be considered very good. All drilling in this hole was carried out using reverse circulation and the material collected was contaminated by interbedded sand and clay units. Therefore, none of the samples were sent for proximate and ultimate analyses although the character of the seams is probably very much like the Gentles Township occurrences.

A second major lignite discovery was made in the 1982 program. This discovery, located in the southeast quarter of McBrien Township and illustrated in Figure 24, consists of several significant lignite seams at depths between 445–525 feet. The thickest of these seams is approximately 23 feet (including a 1-foot clay parting), but there are also several other seams in the range of 3–7 feet. It is possible that these seams correlate with the much thinner seams indicated in drillhole 78-05 (OGS program) but the latter were at considerably shallower depths (350–365 feet) and are approximately 10 km west of the 1982 discovery. However, it has long been known that the Cretaceous sediments progressively thicken as the southern, fault-bounded contact is approached and therefore the lignite units in Hole 78-05 could be stratigraphic equivalents to those in Hole 82-14 despite the considerable differences in



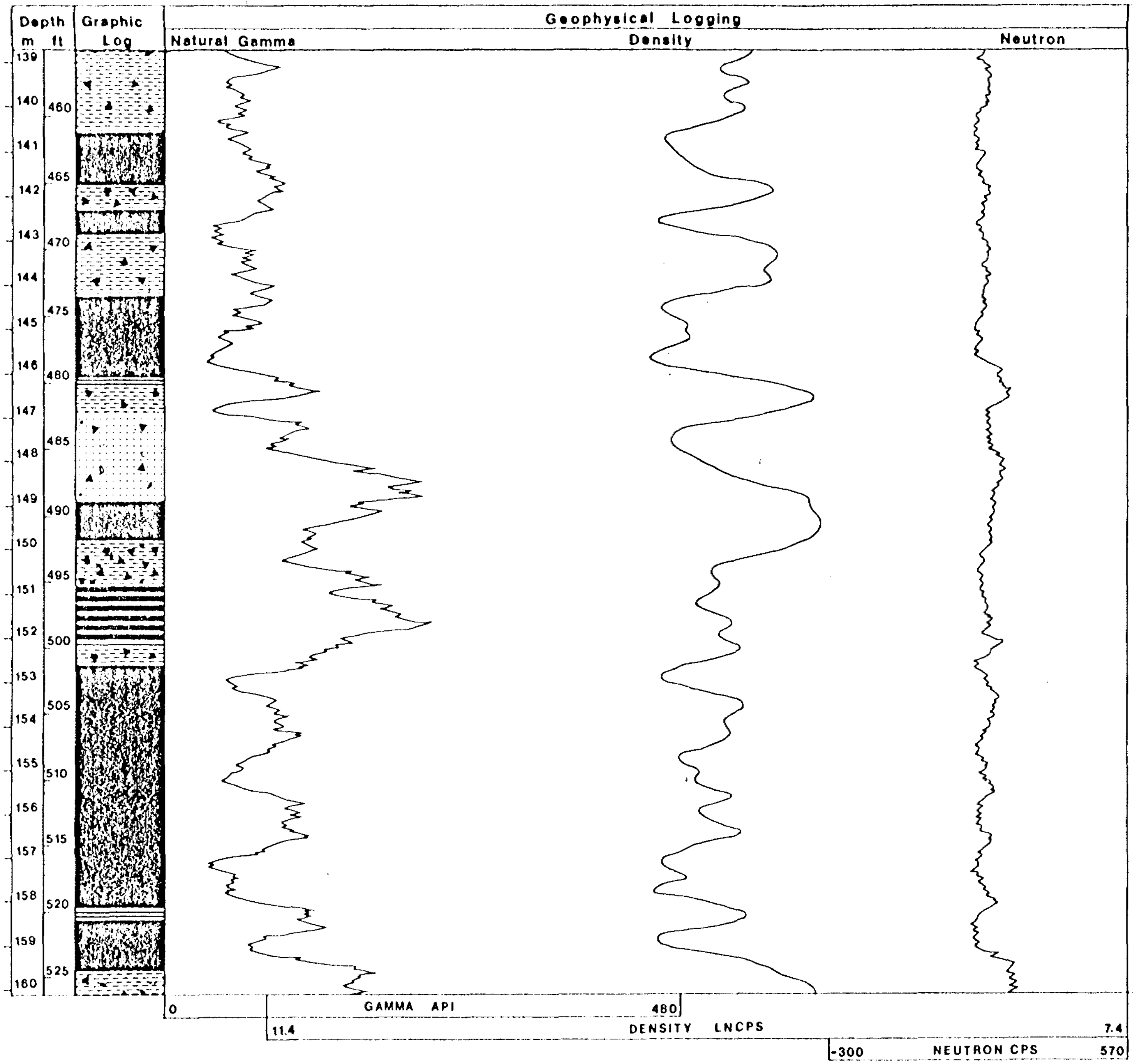
Description

Till: 282.0-286.0': Dark grey clay with minor sand; pebbles.
Clay: 286.0-287.0': Dark grey-black, slightly gritty clay.
Lignite: 287.0-287.8': Lignite grading into dark grey-black clay.
Sand/Clay Sequence: 287.8-304.0': Polymictic medium-coarse grained micaceous sand interbedded with dark grey, gritty, slightly calcareous clay; thin lignite seam at 299.0-299.5'.

Lignite: 304.0-321.0': Contains pyrite as conspicuous blebs and pseudomorphs of lignite; minor fine-grained sand associated with lignite.

Carbonaceous Clay: 321.0-321.5': Very soft, dark grey-black clay containing lignite chips.
Lignite: 321.5-326.5': Lignite with minor dark brown wood chips; up to approximately 15% pyrite blebs.
Carbonaceous Clay: 326.5-328.5': Gritty, stiff clay with woody texture. Contains approximately 10% disseminated pyrite.
Pebble Sand: 328.5-331.0': Bimodal; very fine-grained, light beige quartz sand; pebbles subrounded-subangular quartz, chert, pyrite, and lignite.
Carbonaceous Clay: 331.0-334.0': Very soft, slightly gritty clay with lignite chips.
Lignite: 334.0-343.0': Same as 321.5-326.5', but with approximately 10% pyrite blebs.
Carbonaceous Clay: 343.0-344.5': Same as 331.0-334.0'.
Clay: 344.5-385.5': Light-dark grey, noncalcareous, slightly gritty clay.

Figure: 23 West Gentles Twp. lignite occurence. Geological and geophysical log of part of drill hole ONEX-82-08



Description

Clay: 452.0-461.7': Dark grey with abundant lignite debris; occasional quartz sands (<2").

Lignite: 461.7-465.2': Mostly fragmental with considerable clay and quartz grains; minor FeS_2 and sulphur.

Clay: 465.2-467.2': Grey; abundant coarse lignite chips.

Lignite: 467.2-469.0': Same as 461.7-465.2'.

Clay: 469.0-473.3': Abundant coarse lignite chips.

Lignite: 473.3-480.0': Contains more clay than above; occurs as thin bands and intermixed; includes minor blebs and disseminated pyrite; grades into carbonaceous clay.

Clay and Sand: 480.0-488.5': Quartz sand with abundant coarse lignite chips.

Lignite: 488.5-492.0': Same as 473.3-480.0'.

Clay: 492.0-495.0': Medium-dark grey, gritty clay with abundant lignite chips.

Lignite and Clay: 495.0-500.0': Lignite with thin interbeds of carbonaceous clay.

Clay: 500.0-501.0': Medium grey clay with abundant lignite chips.

Lignite: 501.0-524.0'

501.0-519.0': Lignite with considerable clay; includes some narrow lenses of brown lignite, but most is dark grey to black; much of it fragmental; minor sulphur(?) and pyrite.

519.0-520.0': Mostly medium-dark grey clay.

520.0-524.0': Same as 501.0-519.0', but grades into dark grey, massive clay.

Clay and Sand: 524.0-533.0': Medium grey clay with abundant small lignite chips and quartz grains.

Figure: 24 McBrien Twp. lignite occurence. Geological and geophysical log of part of drill hole ONEX-82-14. Geophysical logging completed in open hole; the relatively poor geophysical signatures are probably the result of irregularities in the hole profile.

depth. Analytical results and the interpretation of the sedimentary environment in which these seams occur are discussed in the following subsections.

7.2.3 ANALYTICAL DATA

A variety of analyses were carried out on 15 lignite core samples from drillholes 82-05 and 82-14. The most important of these are the proximate and heat value analyses that are summarized in Table 8A. Of these samples, four typical examples were selected for the more detailed ultimate analyses (Table 9) and the ash from these four samples were analysed for the major and minor oxides (Table 9A). All of the above analyses were conducted in the CANMET Solid Fuels and Standardization Laboratory in Ottawa under the direction of L. C. G. Janke. In addition, two large samples of lignite were sent to Bondar-Clegg & Co. Ltd. in Ottawa for a detailed analyses of over 20 trace metals (Table 10).

An accurate determination of the moisture content of the lignite from core samples is difficult. Samples RJG-82-01 and RJG-82-09 were complete core samples that were sealed with heavy duty cellophane paper in order to prevent loss of moisture contained in the sample. These two samples yielded moisture contents of 40.5 and 35.1 wt%, respectively. In both cases these results may be a little low as a result of moisture from the sample condensating on the paper seal. We think that most in-situ samples probably have a moisture level of 40–45 wt%. The remaining samples were not sealed because we wanted to examine many of the fine-scale features in the core and therefore their low moisture values are a result of evaporation at room temperatures. Left standing in core boxes, the lignite becomes quite brittle and usually develops many dessication cracks.

The ash content of the various lignite samples is extremely variable. The highest quality lignite samples obviously contain the least ash. In fact, Figure 25 illustrates the average heat value content of lignite samples from the 1981 and 1982 discoveries varying systematically according to the ash content of the sample. The best lignite heat values are just over 10,000 BTU (dry basis) which is a very high range for lignite heat contents, although many are substantially lower. Several ash samples were analysed for major and minor oxides (see Table 9). As expected, sample RJG-82-03 has an ash containing abundant iron and sulphur. This sample also contains abundant calcium, has a high volatile content (LOF), and only moderate amounts of silica and alumina. This indicates that the ash contains only modest amounts of clay.

TABLE 9

ULTIMATE ANALYSES

SAMPLE NUMBER	CARBON		HYDROGEN		SULPHUR		NITROGEN		OXYGEN (by difference)		ASH	HEAT VALUE		COMMENTS
	As Rec'd	Dry	As Rec'd	Dry	As Rec'd	Dry	As Rec'd	Dry	As Rec'd	Dry	Dry	Cal/gm Dry	BTU/lb Dry	
RJG-82-03	36.40	60.96	2.16	3.62	2.01	3.37	0.38	0.64	10.57	17.69	13.72	5,719	10,295	Hole ONEX-82-05: 251–261'; very high quality lignite.
RJG-82-10	25.50	32.64	1.80	2.30	1.41	1.80	0.36	0.46	11.32	14.50	48.30	2,898	5,217	Hole ONEX-82-14: 475–480'; very high ash (clay) content.
RJG-82-13	18.92	25.91	1.32	1.81	0.31	0.42	0.35	0.48	8.79	12.04	59.34	2,235	4,023	Hole ONEX-82-14: 501–510'; very high clay content.
RJG-82-14	38.01	57.94	2.52	3.84	1.22	1.86	0.35	0.53	12.62	19.24	16.59	5,387	9,697	Hole ONEX-82-14: 510–520'; quite good quality lignite.

TABLE 9A

ASH ANALYSES

OXIDES*	SAMPLE NUMBER			
	RJG-82-03	RJG-82-10	RJG-82-13	RJG-82-14
SiO_2	10.33	52.09	66.16	47.12
Al_2O_3	8.80	32.10	23.80	23.42
Fe_2O_3	38.98	6.08	2.50	10.01
TiO_2	0.40	1.49	1.40	1.19
P_2O_5	0.41	0.11	0.14	0.24
CaO	14.75	2.68	2.39	7.26
MgO	2.80	1.14	0.61	1.85
SO_3	11.72	1.53	1.02	3.98
Na_2O	0.45	0.10	0.08	0.26
K_2O	0.05	0.70	0.59	0.60
BaO	0.07	—	0.01	0.08
SrO	0.26	0.06	0.07	0.17
Mn_3O_4	—	—	—	—
LOI	10.90	1.27	1.06	2.16
Total	99.92	99.35	99.83	98.34
Total Ash (dry)	13.72	48.30	59.34	16.59

*All oxide values are in weight %.

TABLE 8

ANALYTICAL DATA* ON THE LIGNITE AND LIGNITIC CLAYS

·sis	PROXIMATE ANALYSIS								HEAT VALUES						LOCATION AND COMMENTS
	Moisture	Ash		Volatile		Fixed Carbon (by difference)		Sulphur Dry	cal/g kcal/kg		MJ/kg		Btu/lb		
	As Rec'd	As Rec'd	Dry	As Rec'd	Dry	As Rec'd	Dry		As Rec'd	Dry	As Rec'd	Dry	As Rec'd	Dry	
2-01	40.47	8.43	14.16	25.52	42.87	25.58	42.97	3.38	3,339	5,609	13.98	23.48	6,010	10,096	Gentles Tp.: Hole ONEX-82-05; 254.0-255.0'; complete core sample was sc moisture determination.
02	38.25	16.60	26.88	22.75	36.84	22.40	36.28	2.27	2,896	4,690	12.12	19.64	5,213	8,442	Gentles Tp.: Hole ONEX-82-05; 246.0-251.0'; split core chip sample.
03	40.29	8.19	13.72	25.61	42.89	25.91	43.39	3.37	3,415	5,719	14.30	23.95	6,147	10,184	Gentles Tp.: Hole ONEX-82-05; 251.0-261.0'; split core chip sample; the 3. (dry) is composed of 2.65% pyritic S, 0.65% organic S, and 0.07% sulphate S.
04	44.30	8.67	15.57	23.49	42.17	23.54	42.26	3.46	3,050	5,476	12.77	22.93	5,490	9,856	Gentles Tp.: Hole ONEX-82-05; 261.0-266.5'; split core chip sample; the 3. (dry) is composed of 2.39% pyritic S, 1.02% organic S, and 0.05% sulphate S.
05	33.70	26.16	39.46	22.56	34.03	17.58	26.51	1.34	2,516	3,795	10.53	15.89	4,529	6,831	Gentles Tp.: Hole ONEX-82-05; 266.5-268.0'; split core chip sample; lignite ash (clay) content.
06	30.83	34.66	50.11	20.20	29.20	14.31	20.69	2.04	1,918	2,773	8.03	11.61	3,452	4,991	Gentles Tp.: Hole ONEX-82-05; 287.0-295.0'; split core chip sample; lignite high ash (clay) content.
07	27.74	44.90	62.14	17.50	24.22	9.86	13.64	1.88	1,310	1,813	5.48	7.59	2,358	3,263	McBrien Tp.: Hole ONEX-82-14; 461.7-465.0'; split core chip sample; ligr very high ash (clay) content.
08	28.55	38.52	53.91	18.49	25.88	14.44	20.21	—	1,881	2,633	7.88	11.02	3,386	4,739	McBrien Tp.: Hole ONEX-82-14; 467.5-469.0'; split core chip sample; ligr very high ash (clay) content.
09	35.09	26.41	40.69	20.45	31.51	18.05	27.80	2.14	2,226	3,429	9.32	14.36	4,007	6,173	McBrien Tp.: Hole ONEX-82-14; 473.6-474.9'; complete core sample was se moisture analysis; 1.40% pyritic S, 0.69% organic S, 0.05% sulphate S.
10	21.88	37.73	48.30	22.26	28.49	18.13	23.21	1.80	2,264	2,898	9.48	12.13	4,075	5,217	McBrien Tp.: Hole ONEX-82-14; 475.0-480.0'; split core chip sample; lignite ash content.
11	27.06	44.51	61.02	15.40	21.11	13.03	17.87	0.25	1,609	2,206	6.74	9.24	2,896	3,971	McBrien Tp.: Hole ONEX-82-14; 482.0-486.0'; split core chip sample; 0.22% p 0.03% organic S, no sulphate S.
12	18.80	57.41	70.70	14.99	18.46	8.80	10.84	0.62	1,109	1,366	4.64	5.72	1,996	2,458	McBrien Tp.: Hole ONEX-82-14; 495.0-500.0'; split core chip sample; lignitic
13	26.98	43.33	59.34	16.46	22.54	13.23	18.12	0.42	1,632	2,235	6.83	9.36	2,938	4,023	McBrien Tp.: Hole ONEX-82-14; 501.0-510.0'; split core chip sample; lign very high ash content; low sulphur.
14	34.40	10.88	16.59	27.02	41.19	27.70	42.22	1.86	3,534	5,387	14.80	22.56	6,361	9,697	McBrien Tp.: Hole ONEX-82-14; 510.0-520.0'; split core chip sample; relati ash and sulphur content.
15	29.48	32.70	46.37	19.78	28.05	18.04	25.58	1.19	2,139	3,033	8.96	12.70	3,850	5,460	McBrien Tp.: Hole ONEX-82-14; 520.8-522.3'; split core chip sample; quite content, but low sulphur.

*ALL VALUES ARE IN WEIGHT PERCENT.

TABLE 10

TRACE ELEMENT ANALYSES

METAL	SAMPLE	
	RJG-82-03	RJG-82-14
Pt[1]	0.008	0.012
Pd	<0.001	<0.001
Au	trace	trace
Ag	nil	nil
As[2]	12	4
Cr	44	4
Co	8	8
Cu	12	10
Pb	12	8
Hg	0.26	0.18
Mo	20	4
Ni	28	14
U[3]	<0.001	<0.001
Th	<0.001	<0.001
Zn	20	6
Mn	32	68
P	0.007	0.018
V	0.001	0.030
W	0.006	<0.001
Sn	0.001	0.002
Se	<0.001	<0.001
Ta	<0.001	<0.001

[1] Pt, Pd, Au, Ag reported as 91/ton.
[2] As, Cr, Co, Cu, Pb, Hg, Mo, Ni, Zn, Mn reported as ppm.
[3] U, Th, P, V, W, Sn, Se, Ta reported in weight percent.

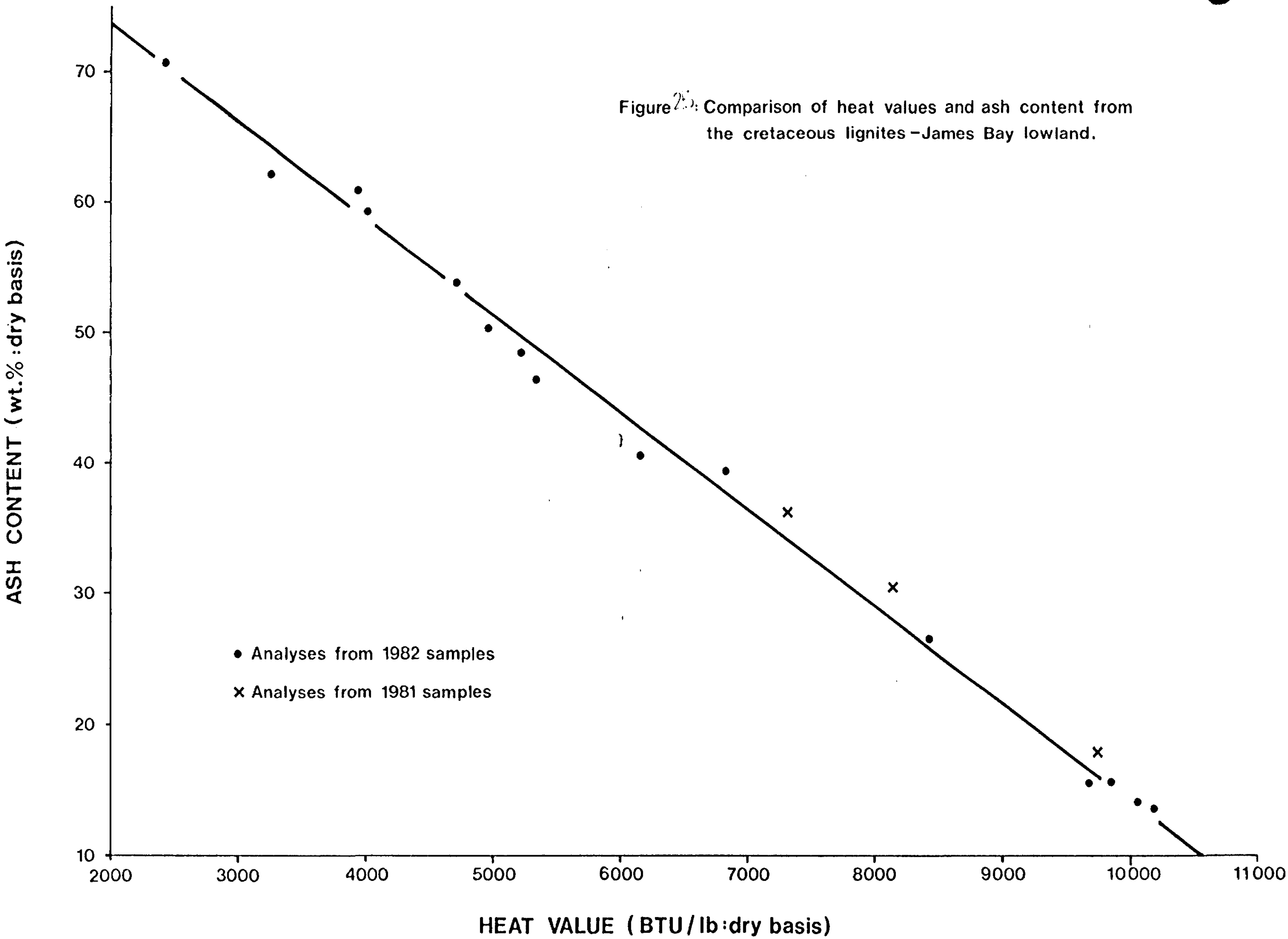


Figure 25: Comparison of heat values and ash content from the cretaceous lignites – James Bay lowland.

The abundant calcium and volatile suggests the presence of calcium carbonate. The two other detailed ash analyses were from lignite samples with a very high ash content. The high silica and alumina contents in these two samples indicates that the ash is composed largely of clay.

Most samples were analysed for total sulphur and selected samples were analysed for the sulphur forms. As with the ash content, there is a great variation in the amount of sulphur contained in the lignite. On a dry basis many of the samples had sulphur values in the range 1–4 wt%. The lignite samples with the highest heat values (i.e., RJG-82-01, RJG-82-03, and RJG-82-04) also have high sulphur (3.4–3.5%), whereas the very clay-rich lignite samples have very low sulphur (less than 1%). In many of the lignite core specimens, as well as in the reverse circulation cuttings, fresh iron sulphide is often observed. The sulphur form determinations certainly verify that pyrite is by far the dominant form. It usually makes up 65–80% of the sulphur, whereas organic sulphur makes up most of the rest. Most samples appear to contain negligible amounts of sulphate sulphur.

The metallic trace element analyses of two ash samples are tabulated in Table [illegible]). The only element that would appear to be anomalous and interesting as a result of a potential economic impact is platinum (Pt). These two samples have Pt values well above the average for coals in general, although Prof. W. Fife from the University of Western Ontario (1981 personal communication) has indicated that some coals/lignites are anomalous in the platinum group metals. As a matter of comparison, 0.01 oz/ton of Pt at a cost of US $400/oz would have an in-situ gross value of $4/ton. Of course, the recoverable value is likely to be far less.

It must be cautioned that platinum is a very difficult metal to analyse accurately and the present results must be further verified before their significance can be properly assessed. The anomalous values could be the result of a sampling error (possible contamination) or from an analytical bias. Further work should examine these possible problems when evaluating other samples for Pt.

7.2.4 SEDIMENTOLOGICAL MODELS

The Cretaceous sediments of the James Bay Lowland were deposited in a nonmarine, continental environment (Price, 1978; WGM, April 1982). Lignite and coal deposits elsewhere in the world are often associated with similar sedimentary environments. In the past few years, detailed studies of known deposits in these environments have indicated a wide variation in the type of nonmarine environment that lignite and coal deposits develop in (see Soc. of Econ. Paleantologists and Mineralogists Special Publication No. 31, 1981: D. G. F. Long, 1981, Geol. Assoc. of Canada Paper 23). The advantage of being able to establish the nature of a sedimentary/aenvironment is that it may help to provide a broad guideline for exploration drilling.

In the 1982 program, Darrel Long, assisted by Catherine Try, examined and reported on the core and reverse circulation data. Their report is included in Volume III of this report. A few comments on their findings are summarized below.

As demonstrated by palynological work done for this year's program (see report by M. L. Richardson in Volume III), the age of the Cretaceous sections containing lignite is very probably Late Albian (approximately 100 million years ago). During this time North America was inundated by a shallow continental sea (Mowry Sea: an illustration of the extent is included in Long's report in Volume III) in the western plains area and was bounded by a rugged upland region in the west (the ancestral Corolillera) and a broad, more gentle upland region in what is now eastern-central Canada. Winder and others (1982) believe that the James Bay Lowland was a broad, relatively flat area drained to the west and northwest by a major river system, coined as the Esoom River by Winder. Pollen species (see report by M. L. Richardson) indicate a climate that could vary from warm to cool temperate, moist conditions, and the vegetation probably included extensive conifers, ferns, and probably flowering plants.

Long believes that evidence to-date is beginning to demonstrate that the fluvial systems associated with the lignite deposits were dominated by vertical accreting river channels. As illustrated in Long's Figure 9 (Volume III), dominant lateral accretion results in very horizontally extensive channel sands and limited floodplain deposits (clays, etc.); whereas, vertical accretion results in much more widespread floodplain deposits and much less channel sands.

In many respects, the present-day James Bay Lowland may be very similar to sedimentary conditions during the time the lignite was formed. The present Mattagami and Missinaibi Rivers are bounded by steep banks that are well-drained and rimmed by thick forest trees (see Figure). Between major rivers most of the present area is very flat and swampy; it is the site for widespread peat deposits. Long argues that Cretaceous lignites could best develop along basin margins and in behind channel levees where the vegetation was rich. Thick deposits (see Figure 10 in Long's report: Volume III) could form if the rivers were successfully constrained to their channels and accreted vertically. Such lignites could be thick and would probably be linear and sinuous in plan. Much thinner, more blanket-like lignite accumulations would form in the inter-channel floodplains, much as the present-day peat layers.

Should the above model be accurate, then it indicates that best lignite deposits could occur along the margins of paleo-channels and perhaps along basin margins where swampy conditions would favour the preservation of dead-organic material, but where flooding would be rare and therefore clay contamination would be minimal. This model may explain why the 1982 drilling in the vicinity of the East Gentles Township lignite occurrence did not discover widespread lateral extensions. This occurrence may be more sinuous and linear rather than blanket-like. This sould be kept in mind when further evaluating new discoveries.

Winder and others (1982) have suggested that the Late Albian Essoom River was constrained to a wide, northwest-trending belt covering a large portion of the western half of the original OEC exploration licence area. Within this belt, the paleo-rivers probably meandered extensively and formed many sandy channel deposits. Therefore, this zone would not likely include important lignite occurrences. However, marginal areas would be better for exploration work. Although this general sand-rich zone is not well defined as yet, it is interesting to note that all the significant lignite occurrences are outside this belt.

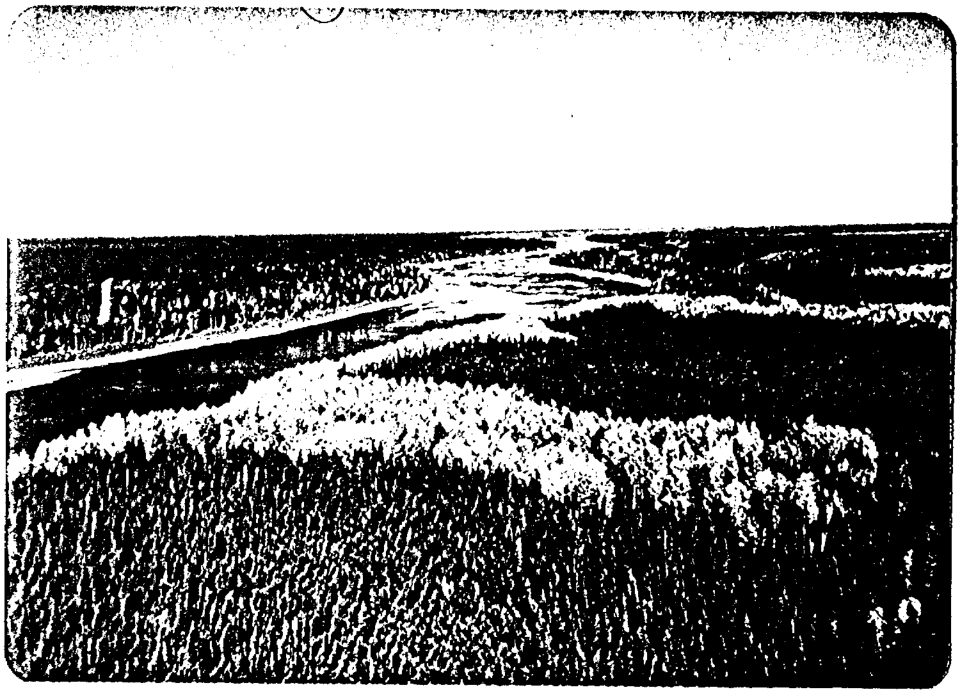


FIGURE 7b : The Mattagami River. The river is relatively well entrenched by steep banks that are heavily forested. Off the sides of the levees (banks) the area is quite swampy (muskeg) and poorly drained.

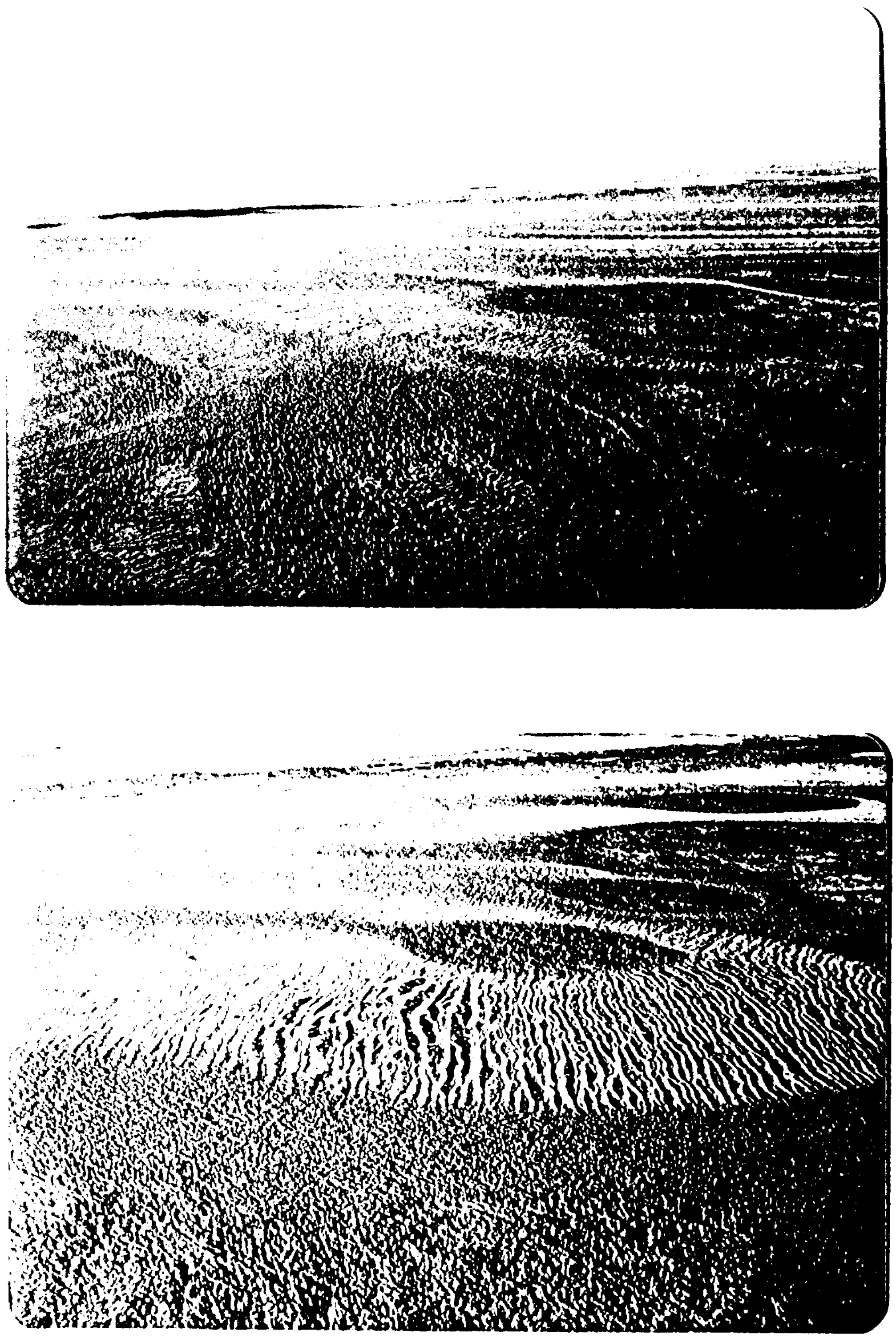


FIGURE [illegible] : Typical continuous bog areas in the James Bay Lowland. The lower photo is a close up view of a string bog. All the area is underlain by peat accumulations of variable thickness.

TABLE [illegible]

SILICA SAND

HOLE NUMBER	FROM–TO	THICKNESS	COMMENTS
5	154.0–179.0	25	Very fine-grained silica sand with minor lignite chips.
	179.0–202.0	23	Sand becoming much coarser with abundant lignite chips.
	202.0–214.0	12	Cyclic lignite/silica sand sequence; ≃2" lignite seam is followed by silica sand.
	228.0–232.0	4	Very fine micaceous sands with thin lignite seams and pyrite blebs.
	299.0–308.0	9	Fine-grained quartz sand within lignitic layers. Sand contains white clay — possibly kaolinitic.
	310.0–319.0	9	Very fine-grained quartz sand; well-sorted and clean.
	319.5–324.0	4.5	Medium to coarse quartz sand with thin seams or detrital lignite. Sand also contains thin white clay layers.
6	133.0–188.0	55	Silica sands contain occasional thin lignitic seam or detrital lignite. Over the 55.0' interval the sands range in size from fine-grained to pebble-sized. Sedimentary and basement clasts are included in the sand.
	191.0–207.0	16	Fine sand with minor lignite and 1–2" pyrite layers.
	225.0–238.0	13	Medium- to coarse-grained sand with minor lignite. Occasional thick
	251.5–258.0	6.5	buff-coloured clay layer occurs within sand seam.
8	387.5–398.1	10.6	Fine- to coarse-grained silica sand with minor lignite.
12	110.5–120.0	9.5	Graded quartz sands with a mixed pebble unit.
	140.0–150.0	10	Silica sand interbed.
	160.0–163.0	3	Fine- to coarse-grained silica sand with minor lignite.
	168.0–172.5	4.5	Medium to coarse sand contains minor white, soft, very gritty clay (possibly kaolinitic).
	199.0–216.0	17	As above with blue-coloured clay appearing intermittently in sand from 210.0–220.0'. White clay interbed at 200.5–200.6'.
	254.0–260.0	6	Some very gritty blue, olive-green, and pale blue clay appear with sand up to 255.0'. At 258.0' white and light grey clay occur in the sand.
	273.0–281.5	8.5	Graded micaceous silica sand containing minor white clay. Very fine-grained to pebble-sized.
	283.0–302.0	19	As above.
	311.5–359.0	47.5	As above with quartz cobbles at 342.0'.
	364.0–369.0	5	As above.
	376.0–390.0	14	As above.
14	49.0– 91.0	42	Moderate amounts of kaolin; no significant mica.
	134.0–141.0	7	Fine to coarse silica sand with minor white clay.
	147.0–174.0	27	Sand as above. Contains a moderate amount of mica. At 154.0' is a 2" layer of white clay.
	188.0–245.0	57	Micaceous silica sands with minor white clay interbeds.
	344.0–358.0	14	Considerable kaolin and noticeable fine-grained muscovite in silica sand.
	366.0–378.0	12	Inferred from missing sections in core.
	382.0–387.5	5.5	As above.
	396.0–417.5	21.5	As above.
15	106.0–147.0	41	Silica sands with minor amounts of grey-white clay, becoming micaceous at 145.0'.
	177.0–250.0	73	Fine-grained quartz sand, minor kaolin, and very minor muscovite; occasional impurities of lithic clasts; rare lignite chips; interbedded coarse and finer sands.
	277.5–290.0	12.5	Lignitic silica sand; minor clay.
	290.0–307.0	17	Sand contains basement fragments — possibly a conglomeratic sand. Minor mica; cyclic bedding.
	372.0–392.0	20	Inferred from missing section in core.
18	139.0–172.0	33	White silica sand with muscovite and minor amounts of white clay.
	174.0–216.0	42	As above.
	226.0–273.0	47	As above but with obvious coarsening upward cycles.
	281.0–285.0	4	Quartz sand with minor white clay and conspicuous flakes of muscovite.

TABLE 12

CRETACEOUS CLAYS

HOLE NUMBER	FROM–TO	THICKNESS	COMMENTS
5	223.1–228.0	4.9	Clays are non-gritty, soft and micaceous; possible thin lignitic seams after 224.5'.
	238.0–246.0	8	Carbonaceous clay with trace lignite and occasional very fine-grained sand seams.
	270.5–279.5	9	Micaceous clays.
	282.0–287.0	5	Clay contains both fragmental lignite and thin lignitic seams. Occasional flecks of muscovite occur in clay.
	296.0–302.0	6	Carbonaceous clay with abundant lignite.
	222.0–223.5	1.5	Tan-medium grey clay and thin pyrite layers. Non-gritty and slightly micaceous.
	238.0–241.0	3	Buff-coloured kaolinitic clay and trace lignite.
8	344.5–349.5	5	Light grey, non-gritty, soft clay.
	352.0–355.0	3	Medium grey as above.
	370.0–372.0	2	Dark grey as above.
	375.0–382.0	7	Green-grey clay, as above, becoming a white clay with black mottles at 378.0'.
12	120.0–137.0	17	Thinly layered and laminated variegated clays; abundant lignite chips from 130.5–137.0'.
	186.0–199.0	13	Variegated clays as above.
	216.5–218.0	1.5	White soft clays — possibly kaolinitic.
	221.0–243.2	22.2	Variegated clays as 120.0–137.0'.
	245.5–246.5	1	Red clay in variegated clays as above.
	260.0–269.0	9	Variegated clays.
	307.0–311.5	4.5	Variegated clays becoming micaceous at 311.0–311.5'.
13	358.5–367.0	8.5	Thinly layered and laminated variegated clays.
	390.0–392.0	2	As above.
	393.0–398.0	5	As above.
14	91.0–112.0	21	Variegated clays.
	114.0–119.0	5	As above.
	120.0–124.0	4	As above.
	142.0–145.0	3	Tan clay; stiff, non-gritty, noncalcareous. At 144.0' there is a 2" layer of white clay.
	174.0–176.0	2	Tan soft clay.
	179.0–181.0	2	White soft clay.
	185.0–188.0	3	Tan clay with rust mottling.
	247.5–251.0	3.5	Brick-red clay with yellow mottling.
	333.0–344.0	11	Variegated clays.
	392.0–396.0	4	As above.
	544.5–571.0	26.5	Chocolate, brown, and grey clay; minor red mottling at 562.0'.
15	250.0–268.0	18	Variegated clays.
	269.0–277.5	8.5	As above.
	307.0–350.0	43	Clay becoming micaceous by 340.0'.
	405.0–411.0	6	Silty clay with very fine laminae.
	421.0–437.0	16	As above.
18	116.0–123.0	7	Variegated clays.
	216.0–223.0	7	Light grey, stiff, non-gritty clay becoming darker by 222.0'.
	273.0–281.0	8	White, non-gritty, soft clays.
	288.0–298.5	10.5	Grey clays becoming carbonaceous from 292.0–293.5'. Minor lignite chips appear at 288.2'.

7.2.4 CONCLUSIONS AND RECOMMENDATIONS

The 1982 drill program resulted in the discovery of two new major lignite occurrences. The program also indicated that the 1981 discovery is not likely to be an extensive, blanket-like occurrence, but rather may be a sinuous, irregular deposit. The East Gentles, West Gentles, and McBrien discoveries all have potential as large lignite reserves, and clearly indicate that the Cretaceous sediments in the James Bay Lowland deserve a more systematic evaluation using closely-spaced grid drilling. The East and West Gentles discoveries clearly point out that the Crown land north of the Missinaibi River has great exploration potential for extensions of known occurrences or entirely new deposits.

It is recommended that both regional and local drilling programs be conducted in the licence areas. Most of the effort should be directed towards a systematic regional drill program using 5–10 km hole-spacings in the northern licence area. Both the East and West Gentles discoveries warrant at least five holes, to better define the character and geometry of these occurrences. In addition, several holes are warranted in southern McBrien and Garden Townships in order to trace possible extensions of the deep seams discovered in this area.

7.3 SILICA SANDS

7.3.1 GENERAL DISTRIBUTION AND DESCRIPTION

One of the prominent lithological characteristics of the Cretaceous units of the Moose River Basin is the widespread presence of unconsolidated quartz-rich sands, often referred to as silica sands. These sands have attracted considerable attention for their possible economic uses; numerous companies have carried out test-work and/or market surveys. The most notable of these is the Algoma Steel Company, which currently maintains a lease-area on the Missinaibi River. Algoma's interest results largely from their need for foundry silica-sand; the Algoma Central Railway could provide a cheap, well established transport system that would make the large steel-foundry markets in the Great Lakes region readily accessible. In addition, the silica sands in the Algoma

Steel (Algocen) lease-area contain a substantial amount of relatively pure kaolin clay, which could also be important commercially. However, no major commercial exploitation of these deposits has been attempted to-date.

In recent years, several reports on the silica sands have been published. The most comprehensive of these are by A. P. Hamblin (in Telford and Verma 1979) and, more recently, by M. A. Vos (1982).

Silica sands are extremely widespread throughout the ONEXCO licence area, and are encountered in virtually every drillhole that intersects Cretaceous beds. According to Winder and others (1982), the most extensive silica sands occur in a northwest-trending belt across the western part of the licence area and are related to a large Cretaceous (Albian) river system (the Esoom River) that drained this region. The drilling carried out by OEC in 1981 and 1982 tended to confirm this general distribution. Table 12 summarizes the main silica sand occurrences encountered in the 1982 drill program. Locations for the drill holes are shown in Map 1 in the map pocket of this volume.

Most of the silica-sand occurrences are a light grey to buff colour. Reverse-circulation cuttings are usually quite white because of the clay suspended in the water returns. Grain sizes can be extremely variable, although most are in the fine-to-medium size range. Most grains are angular to subangular and often quite transparent. The finer particles tend to be more angular and transparent than the coarser fractions.

Most sands contain minor amounts of kaolin. It is difficult to estimate how much kaolin occurs in sands that are sampled by reverse-circulation techniques; almost invariably, a substantial amount of the clay is washed away. Our estimate is that most sand occurrences contain less than 7–10 modal% kaolin (and other clays). However, in some cases the clay content is substantially higher; and in private reports of early work in this region, estimates as high as 15% have been stated.

The remaining accessory minerals usually compose only 2–5% of the rock. Those that are most common include various resistant metamorphic silicates, siderite, ilmenite, iron oxide, zircon, rutile, and (occasionally) one or more sulphides. In addition, some sands contain noticeable muscovite, mostly fine-grained but in some occurrences as coarse as 2–5 mm. Over restricted thicknesses, some sands may contain up to 10% muscovite; but most contain less than 2%.

A more detailed analysis of the heavy-mineral content of many Cretaceous sand samples from the 1982 drill program is reported in Volume III (Overburden Drilling Management) of this report.

7.3.2 ANALYTICAL DATA

Numerous sand samples were submitted to the Ontario Research Foundation for test work. Results of this testing are summarized in the report by Joyce and Booth (see Volume III). The test-work was intended to evaluate possible commercial uses for the silica sands. The testing was not comprehensive, because the silica-sand potential in the licence area is considered secondary to that of lignite.

Particle-size distribution is an important characteristic of sands used for glass melting or foundry purposes. Most of the Cretaceous sands from the 1982 program exhibit a wide range of particle sizes, although most appear to be either fine-grained or relatively coarse. However, it is unlikely that this size-distribution is typical of most sands from this region; almost certainly, medium-grained deposits are quite widespread.

Five typical sand samples were analysed for composition (see the ORF report in Volume III). The analytical method used was the ICP "plasma" system, which has precision estimates that are unsuitable as detailed, quantitative analysis. However, it does provide a good composition estimate for present needs. The silica (SiO_2) content of the sands is in the range of 97.5–99.5 wt%. It should be emphasized that these analyses were carried out on sample "heads" that represent the +325 mesh size material. The -325 mesh material was removed by sieve analysis as the clay fraction. In the five sand samples analysed, the clay fraction came to approximately 1%; although one sample (82-16; 250–260 feet) was approximately 4% -325 mesh material.

With treatment by flotation and magnetic separation, the sand composition should be easily upgraded to +99% SiO_2. This is not obvious from the chemical analyses reported by ORF. Discrepancies are surely due to limitations in the analytical procedures.

7.3.3 POSSIBLE MINING METHOD

A pre-feasibility study of the Cretaceous sands and clays has recently been sponsored by the Ontario Geological Survey. Results of this study should be available in late December 1982 or early January 1983. We have been told that this study will deal, in part with possible mining methods applicable to the Cretaceous sands.

The low unit-value of the quartz sands (with or without clay) indicates that an inexpensive, low capital-cost system of mining would be necessary for a silica sand mining operation to be economic. Although surface operations are generally low-cost, they have such environmental impact as may limit their application. A relatively new underground system of mining has been pioneered and tested by the United States Bureau of Mines: the hydraulic borehole or borehole-slurry mining system.

The borehole-slurry system may be well suited to mining the Cretaceous silica sands and clays. Figure 29 is a schematic representation of the system. It operates much the same as reverse-circulation drilling: water under high pressure is pumped down one chamber of drill-string, and exits through a special hydraulic cutting tool; cuttings are then sucked up through a separate chamber in the rods. The resulting slurry can be directed into a settling pond, or directly into a milling circuit if any beneficiation is required.

These silica sands may be ideally suited for this system, because the sand is almost entirely unconsolidated and occurs in thick sections where large tonnages are easily available. The thick sections would require few moves. There would be no need to be concerned about supporting walls, since the surrounding material would slowly seep or slump into the mined-out areas; surface sink features of any significant size are unlikely to develop.

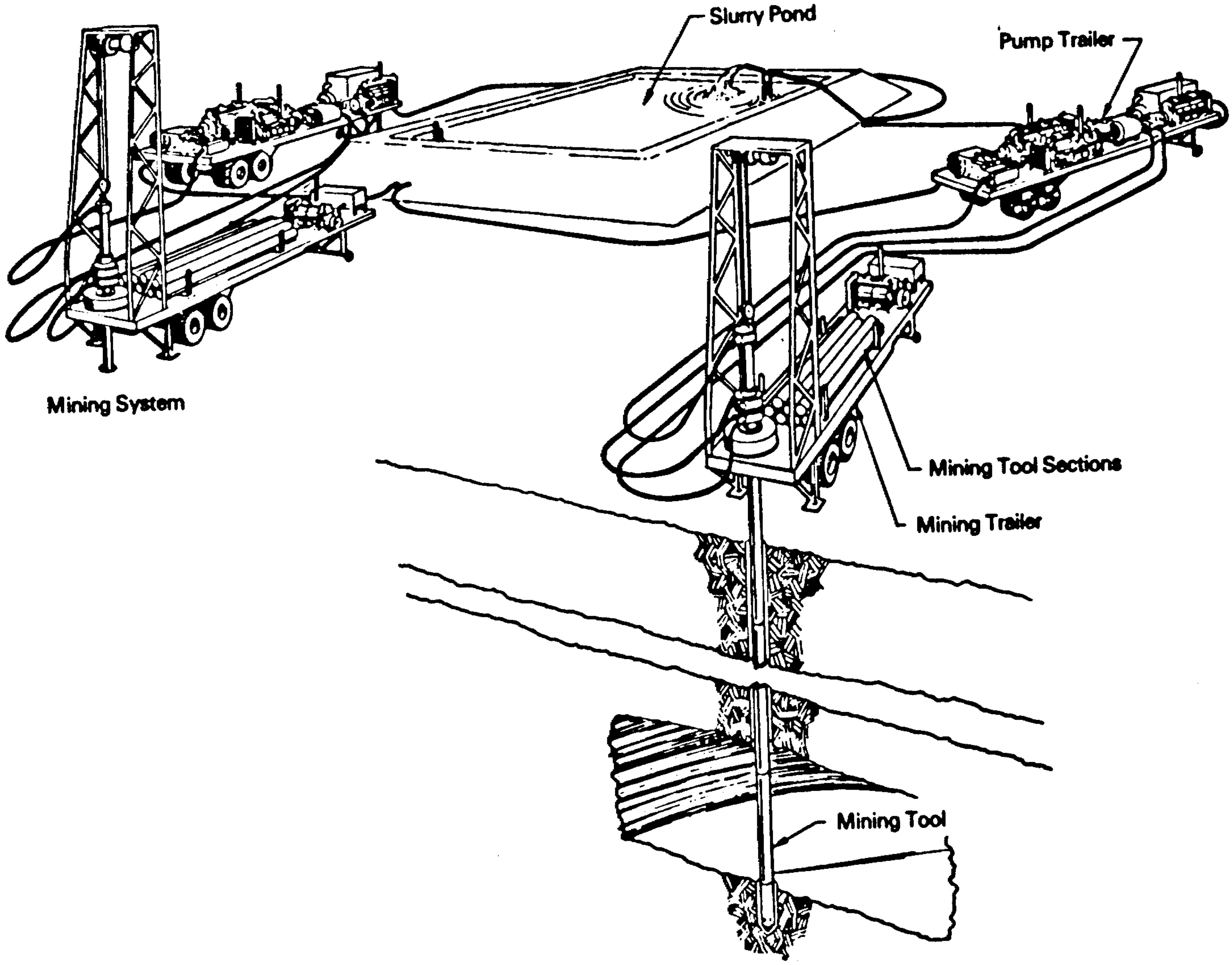


FIGURE 29: Borehole mining system (from Archibald 1978).

The borehole system has been tested on a variety of mineral deposits, and has been developed to mine at a rate of 8 tons per hour. Larger prototypes are now being designed (G. Savanick, USBM, personal communication 1982).

7.3.4 CONCLUSIONS AND RECOMMENDATIONS

Silica sands suitable to several important industrial needs occur in most parts of ONEXCO licence areas.

Past economic studies of silica sands for in this area have suggested that they were not economic. Later studies, however, generated increased interest in the associated kaolin clays. The pre-feasibility study recently sponsored by the Ontario Geological Survey will update mining and marketing factors that will be critical in re-evaluating these deposits. However, lack of an established infrastructure, as well as the present depressed economy do not augur well for the near-future development of these silica sands.

During any future lignite exploration work in the licence area, it would be wise to systematically log and sample all sand units. Selected samples should be tested in detail for composition and size distribution. A limited number of detailed chemical analyses should also be conducted. Samples of drill returns should be taken carefully, to better evaluate the character and amount of the clay fraction.

7.4 CLAYS

7.4.1 INTRODUCTION AND GENERAL DESCRIPTION

A variety of clays are found throughout the Cretaceous units of the Moose River Basin. These clays, like the silica sands, have been known for decades and periodically have been evaluated for their economic potential. Although Algoma Steel was initially interested in the silica sands on their Missinaibi lease area, they eventually became increasingly interested in the possibility of recovering and selling the kaolin clay that is contained in these silica sands. Their principal aim was to evaluate clays for the high-quality coating and filler markets. Test-work demonstrated that their Missinaibi clays would probably need considerable beneficiation in order to meet specifications. However, the untreated clays appear to be quite suitable for many industrial needs.

Over the years, industrial mineral companies have examined and drilled a number of known clay occurrences in Kipling Township (north of Smokey Falls), but the results of these studies are unavailable to us.

In the 1982 drill-program, clay units were systematically logged and, in many cases, sampled for further testing. Table 13 summarizes the more important Cretaceous clay occurrences intersected. As this summary indicates, the clays occur in a variety of colours — tan, grey, light green, red, dark brown, and occasionally white. They occur as thin, finely laminated units or in thicker, massive beds. As mentioned in the previous subsection, many of the silica sands contain a significant amount of clay, most of which is white kaolin.

Some of the clay beds are quite pure, although others are often gritty and appear to contain substantial silt and sand-sized quartz grains. It is difficult to evaluate the detailed features of clays when using the reverse-circulation drill system; the clays often clog the bits and get mixed in with coarser clastic units with which they may be interbedded.

We have not attempted to do detailed mineralogical analyses of Cretaceous clays. In the test-work carried out as part of the 1981 program, several samples were analysed using an X-ray diffractometer. Since these samples were mostly reverse-circulation cuttings, they almost certainly have been contaminated to some degree by quartz grains. Nevertheless, the main layered silicate minerals are kaolinite (aluminum-rich clay) and illite (potassium- and aluminum-rich clay). Earlier work by Guillet (1979) indicated that most of the clays analysed in the 1978 Ontario Geological Survey drill-program were dominated by kaolinite, although illite was also quite widespread.

As discussed in the previous subsection, muscovite is fairly abundant in some sand samples. It is also likely that many of the clay units also contain fine-grained

TABLE 13

CRETACEOUS CLAYS

HOLE NUMBER	DEPTHS (feet)	THICKNESS (feet)	COMMENTS
ONEX-82-05	223.1–228.0	4.9	Clays are non-gritty, soft and micaceous; possible thin lignitic seams after 224.5'.
	238.0–246.0	8	Carbonaceous clay with trace lignite and occasional very fine-grained sand seams.
	270.5–279.5	9	Micaceous clays.
	282.0–287.0	5	Clay contains both fragmental lignite and thin lignitic seams. Occasional flecks of muscovite occur in clay.
	296.0–302.0	6	Carbonaceous clay with abundant lignite.
	222.0–223.5	1.5	Tan to medium-grey clay and thin pyrite layers. Non-gritty and slightly micaceous.
	238.0–241.0	3	Buff-coloured kaolinitic clay and trace lignite.
ONEX-82-08	344.5–349.5	5	Light grey, non-gritty soft clay.
	352.0–355.0	3	Medium grey, as above.
	370.0–372.0	2	Dark grey, as above.
	375.0–382.0	7	Green-grey clay, as above, becoming a white clay with black mottles at 378.0'.
ONEX-82-12	120.0–137.0	17	Thinly layered and laminated variegated clays; abundant lignite chips from 130.5–137.0'.
	186.0–199.0	13	Variegated clays, as above.
	216.5–218.0	1.5	White soft clays — possibly kaolinitic.
	221.0–243.2	22.2	Variegated clays, as 120.0–137.0'.
	245.5–246.5	1	Red clay in variegated clays, as above.
	260.0–269.0	9	Variegated clays.
	307.0–311.5	4.5	Variegated clays becoming micaceous at 311.0–311.5'.
ONEX-82-13	358.5–367.0	8.5	Thinly layered and laminated variegated clays.
	390.0–392.0	2	As above.
	393.0–398.0	5	As above.
ONEX-82-14	91.0–112.0	21	Variegated clays.
	114.0–119.0	5	As above.
	120.0–124.0	4	As above.
	142.0–145.0	3	Tan clay; stiff, non-gritty, noncalcareous. At 144.0' there is a 2" layer of white clay.
	174.0–176.0	2	Tan soft clay.
	179.0–181.0	2	White soft clay.
	185.0–188.0	3	Tan clay with rust mottling.
	247.5–251.0	3.5	Brick-red clay with yellow mottling.
	333.0–344.0	11	Variegated clays.
	392.0–396.0	4	As above.
	544.5–571.0	26.5	Chocolate, brown, and grey clay; minor red mottling at 562.0'.
ONEX-82-15	250.0–268.0	18	Variegated clays.
	269.0–277.5	8.5	As above.
	307.0–350.0	43	Clay becoming micaceous by 340.0'.
	405.0–411.0	6	Silty clay with very fine laminae.
	421.0–437.0	16	As above.
ONEX-82-18	116.0–123.0	7	Variegated clays.
	216.0–223.0	7	Light grey, stiff, non-gritty clay becoming darker by 222.0'.
	273.0–281.0	8	White, non-gritty, soft clays.
	288.0–298.5	10.5	Grey clays becoming carbonaceous from 292.0–293.5'. Minor lignite chips appear at 288.2'.

muscovite (sericite). This potassium-rich mica, which may be difficult to distinguish in clay samples, could be the source from which the illite is derived.

7.4.2 ANALYTICAL DATA

A few typical clay samples obtained in the 1982 drill program were dispatched to the Ontario Research Foundation for limited test-work. Results of this work, summarized by I. Joyce and C. Booth, are contained in Volume III of this report; only general comments on the results are mentioned here.

Most of the clays tested do not appear to be suitable for high-quality uses. This is largely a result of their firing characteristics: high-quality products must fire white, whereas most of the above samples fired to an orange or brownish colour. The discolouration is probably due to iron oxide impurities, which will severely limit their refractory applications.

One whitish to light grey clay sample produced a relatively white fired product with a reflectance of approximately 70%; high-quality kaolin usually has a reflectance of 90% or greater. A bleaching treatment of this sample resulted in almost no improvement in the reflectivity.

Several of the clay samples appear to be extremely fine-grained; as a result, they tend to be very plastic. This feature could be a detriment in ceramic applications because of shrinkage and cracking problems.

7.4.3 CONCLUSIONS AND RECOMMENDATIONS

Most of the clays encountered in the 1982 drill-program are not suitable for high-quality products. However, they may be useful in pottery and brick applications. Such applications would require extensive local infrastructure and a transportation system that would permit access to large construction and manufacturing markets.

There is potential for large reserves of high-quality clay in the Cretaceous sediments. Much more systematic drilling and test-work is required to further evaluate this potential. Should large reserves of good-quality clay be established, then the borehole-slurry system of mining could be an inexpensive and efficient method of recovering the clay.

Any future lignite exploration drilling program in this region should systematically log and sample clay units. Wherever possible, the clays should be cored rather than drilled using reverse-circulation because core specimens are likely to be less contaminated. Any of the Cretaceous sands containing substantial amounts of clay should also be carefully sampled in order to estimate the quantity and quality of the accessory clay. Standard testing (firing, reflectance, size analysis) should be carried out on selected samples.

7.5 HEAVY MINERAL STUDIES

7.5.1 DISCUSSION AND SUMMARY OF RESULTS

As part of the 1982 lignite exploration program, it was decided to examine concentration of the heavy minerals from any Pleistocene and Cretaceous clastic sediments. These sediments consist largely of Pleistocene tills, interglacial sands and gravels, and the quartz-rich sands that characterize much of the Cretaceous in the James Bay Lowland. Heavy minerals are useful in exploration for base metals, precious metals, some strategic and alloy metals, uranium, and diamonds. In the licence area, diamonds are the most attractive and realistic target.

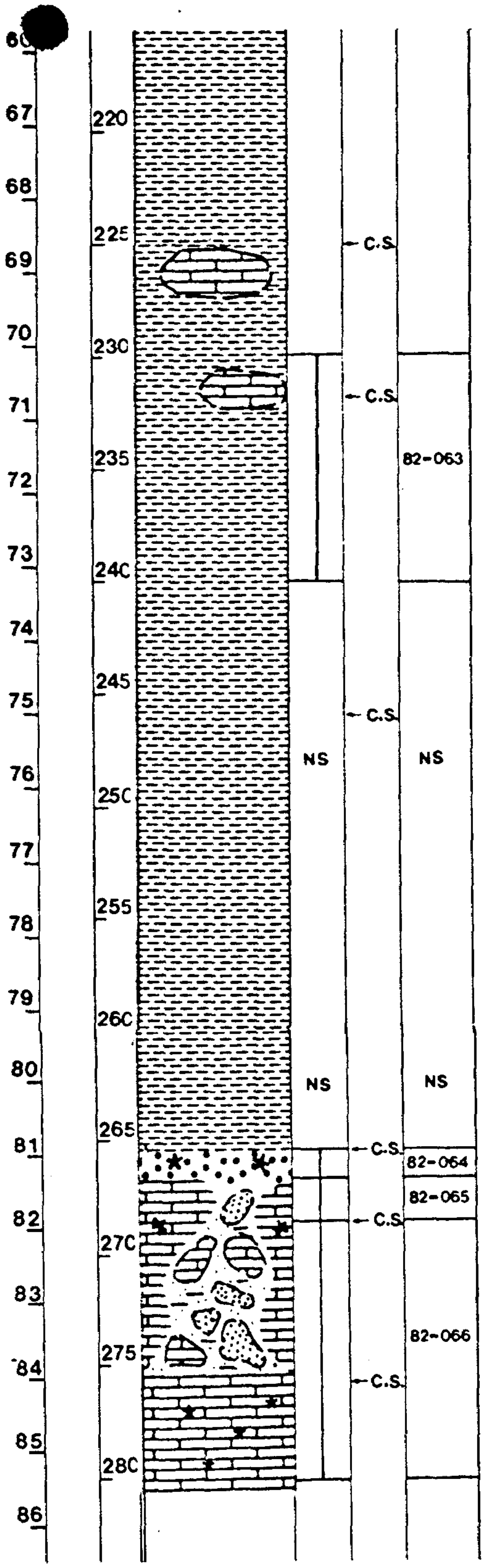
Selco Inc. has been conducting a diamond-exploration program in the James Bay Lowland for several years; they currently hold a large licence area immediately adjacent to the original OEC licence. Over the past 20–30 years, numerous other companies have conducted diamond-exploration programs in the region; and although a number of kimberlite-indicator minerals have been discovered in this region, we know of no diamond discoveries to-date. Kimberlite-like rocks (possibly lamprophyres) exist at Coral Rapids on the Abitibi River, and other kimberlites probably occur buried in this area. The WGM 1981 report discusses the history of diamond exploration in this area.

In general, there are two approaches to diamond exploration in this general region. One includes detailed, high-resolution aeromagnetic surveying, followed by more detailed ground-magnetometer surveys in areas where aeromagnetic anomalies occur. Detailed surveys are necessary because the kimberlite targets do not have a strong magnetic signature and they are often small — perhaps 50–100 m or less, in diameter. However, even when buried beneath relatively thick Pleistocene and/or Cretaceous sediments (largely nonmagnetic), it is theoretically possible to detect such bodies. This strategy was followed by Selco in much of their licence area.

A second approach involves prospecting for heavy minerals known to be associated with diamantiferous kimberlites. This method attempts to discover secondary (alluvial) diamond deposits or primary kimberlite targets by systematically tracing the dispersed indicator minerals. The main indicators are pyrope (Mg-rich) garnet, chrome diopside, and a magnesian-rich variety of ilmenite. This approach has been successful in various parts of the world, particularly in Russia, where extensive heavy-mineral exploration programs resulted in the discovery of diamantiferous kimberlites in Siberia.

In 1982, WGM recommended that all reverse-circulation cuttings from Pleistocene and Cretaceous clastic units be sent to Overburden Drilling Management Limited (ODM) in Ottawa for concentration and visual examination of heavy minerals. The main aim was discovery of kimberlite indicator minerals; a secondary aim was evaluation of the presence of various metallic elements. The detailed report by ODM is included in Volume III of this report.

The only highly significant anomaly resulting from the heavy-mineral studies was the discovery of pyrope garnet in Samples 82-064 and 82-065. These two samples were taken from drillhole ONEX-82-03 in the southeast quarter of McCuaig Township, quite close to the Missinaibi River (see Map A in pocket of this volume). The section from which the samples were taken is illustrated in Figure 30. The stratigraphy in this section is not well understood and has posed a few problems in interpretation. The



CLAY WITH LIMESTONE CLASTS(?): 225.0-232.0'

Light green limestone integrated with light green and dark brown, soft to stiff, noncalcareous clay. Source and character of limestone is not fully understood.

229.0': Possibly the edge of a boulder.

CLAY: 232.0-265.5'

Alternating layers of light green, tan, red, and chocolate brown clays; calcareous, soft to stiff, and slightly gritty. Occasional limestone clasts appear at 242.0'; whereas, sandstone clasts occur infrequently at 248.0' and 258.0'.

SANDSTONE: 265.5-267.0'

Light green gritty clay with a quartz-rich sand matrix and pebble-sized subangular clasts. Clasts are a pyrite-rich sandstone; sand grains are predominantly rounded.

SOLUTION COLLAPSE BRECCIA

At 267.0' clasts are dominantly limestone and siltstone with minor pyrite. From 270.0-275.0' limestone and dolomite fragments occur in very light grey soft sandy clay.

LIMESTONE/DOLOMITE: 275.0-280.0'

Pyritiferous carbonates.

280.0': END OF HOLE

FIGURE 30: Partial log from drillhole ONEX-82-03. The pyrope anomalies are from Samples 82-064 and 82-065.

sand material at depths approximately 265–269 feet appears to be very similar to other Cretaceous sands, in that the grains are almost all quartz and in part it is cemented by pyrite. The heavy-mineral suite is also similar to other Cretaceous sands. However, the grains are more rounded than most Cretaceous sands and the section above the sand is dominated by a thick section of variegated clays, some of which are calcareous. Within the clay section are what appear to be small limestone blocks or boulders restricted to narrow intersections. Since this section was drilled using reverse circulation, it is difficult to be certain, but the clays are probably Cretaceous (Middle Albian, possibly Aptian?) in age and that the limestone debris may have been brought in (rafted?) from nearby limestone exposures in the Grand Rapids Arch. Alternatively, this entire section could be part of a large sinkhole deposit formed within a Devonian limestone host (probably Williams Island Formation). The intersection below 269 feet has characteristics suggestive of a sinkhole breccia, and the hole did bottom in a limestone/dolomite. In either case, the sands from which the pyrope were recovered are probably Cretaceous, whether from a sinkhole or a thin channel sand.

The concentration of pyrope in Sample 82-065 is very high (33 grains from a 28.9 g concentrate; the original sample was approximately 5.6 kg), and the grains are relatively coarse. No other kimberlite indicator minerals were recognized.

It would appear that the pyrope is associated with a channel sand that may be a basal Cretaceous unit unconformably overlying Paleozoic sediments. The stream that deposited the sand and concentrated the pyrope may have been small, and probably drained from the south, perhaps off exposed areas of the Grand Rapids Arch.

7.5.2 CONCLUSIONS AND RECOMMENDATIONS

The discovery of a high concentration of pyrope in a basal(?) Cretaceous channel sand is significant. The source for the pyrope may be a kimberlite or eluvial concentration located south of the present pyrope anomaly. The sand is related to a stream channel that is probably not very large and therefore did not drain a large area. Follow-up work on evaluating the pyrope anomaly is certainly warranted.

7.6 OIL SHALE

7.6.1 INTRODUCTION

The oil shales of the Moose River Basin have their origin in the marine organic-rich muds that were deposited in the shallow seas covering all of Ontario and most the eastern United States during Late Devonian time. In the Moose River Basin, these mudstones and claystones are found in the Long Rapids Formation; the age and lithological equivalent of the Chattanooga – Ohio – New Albany – Antrim shales of the eastern United States and of the Kettle Point Formation in southwestern Ontario. These formations, particularly the Chattanooga and the Ohio, have been the subject of considerable exploration activity in recent years, both for oil shale and uranium.

In 1981, WGM carried out a preliminary investigation of the potential oil shale formations of Ontario for the OEC. The Long Rapids Formation was included in this study and various analytical procedures were carried out on core obtained from Ontario Hydro and core from the 1981 Lignite Program. A 52-foot section of core from Ontario Hydro drillhole LX-7A (true thickness 6 feet) yielded 8 US gallons/ton of oil from Fischer Assay and had an organic carbon content of 7.54%. Within this core there is a 16-foot section (true thickness 11 feet) which compares favourably with the best of the results from the eastern United States oil shale investigations, as shown on the following table:

Location	Formation/ Member	Thickness (feet)	Fischer Assay (US gal/ton)	Fischer Assay Range (US gal/ton)
East Central Tennessee	Gassaway	22	10.5	9.6–11.0
Kentucky	Sunbury	16	10.3	9.2–11.6
	Cleveland HGZ	30.8	11.9	10.8–13.0
Abitibi River (LX-7A)	Long Rapids	11	10.2	7.5–14.0

7.6.2 1982 INVESTIGATIONS

There was no official investigation of the oil shale of the Moose River Basin planned for 1982. However, as the lignite program was being carried out in the area, it seemed opportune to sample outcrops of the Long Rapids Formation along the east and west banks of the Abitibi River just downstream from the site of Ontario Hydro drillhole LX-7A (see Figure for locations). In addition, samples of core were taken from four of the lignite exploration holes, drilled into the Long Rapids Formation; these holes were ONEX-82-01, ONEX-82-04, ONEX-82-05, and ONEX-82-18.

The outcrop area straddles the Williams Island anticline and is located in the eastern part of the Moose River Basin. The Upper Devonian Long Rapids Formation and the underlying Williams Island Formation both derive their names from this location. The Abitibi River has cut into the surrounding muskeg and some 30 feet of overburden, consisting of muskeg, marine clays, tills, and some 6 feet of the Cretaceous Mattagami Formation, overlies the Long Rapids Formation in this area. The Cretaceous sediments consist of interbedded green and grey clays with dark bands of organic-rich clay.

Several minor fold strucutres are superimposed on the main anticlinal structure. One of these, a small anticline, was delineated by Ontario Hydro drilling. The crest of this anticline trends 110° and is situated between LX-3 and LX-7A bringing the Williams Island limestone to surface in the riverbed. Dips on either side of this structure are about 20° to the north and south, respectively.

In the subsurface in the area, the most complete section of the Long Rapids Formation is present in the ODM Onakawana drillhole A. In this drillhole Dyer and Crozier (1933) subdivided the Long Rapids Formation into three informal lithologic members:

	Thickness at Onakawana (feet)	Lithology
Upper Member	68	Interbedded greenish-grey clay and clay shale.
Middle Member	97	Dark bituminous shale with thin bands of greenish-grey clay.
Lower Member	120	Pale greenish-grey clay to grey shaly clay with bands of dark bituminous shale and hard concretionary material.

These informal divisons are easily identifiable both in outcrop and in core. It is the middle member consisting predominantly of black and grey 'bituminous' shale which is

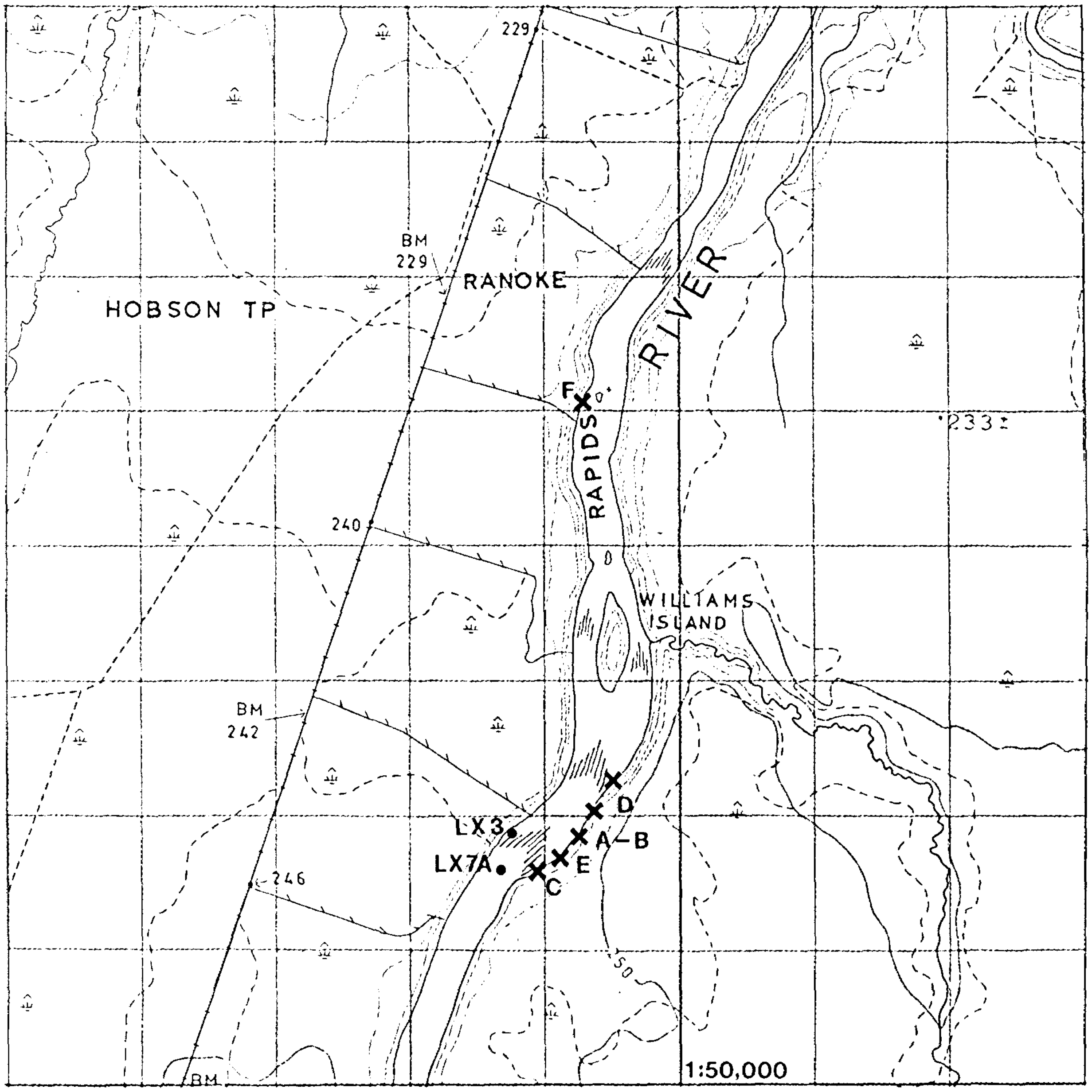


FIGURE : Oil shale sampling sites near Williams Island, Abitibi River.

of most interest to this program. Only the lower member and the middle member are present in the immediate area. The lower member is 38 feet thick both in Hydro drillholes and in outcrop. The lower 37 feet of the middle member is present in LX-7A and it is within this section that an average yield of 8 US gal/ton over 36 feet was obtained during the 1981 program.

Outcrop in this area occur along steep clay banks rising straight out of the water to a height of 50 feet. Thus, it is only possible to sample most of the outcrop sections when the river is artificially lowered by controlling the flow at the Otter Rapids Dam upstream.

The outcrop sampling program consisted of sampling the lower 44 feet of the middle member of the Long Rapids Formation composited from five outcrop sections. The lithology of the five sections and the composite section are shown graphically on Figure .

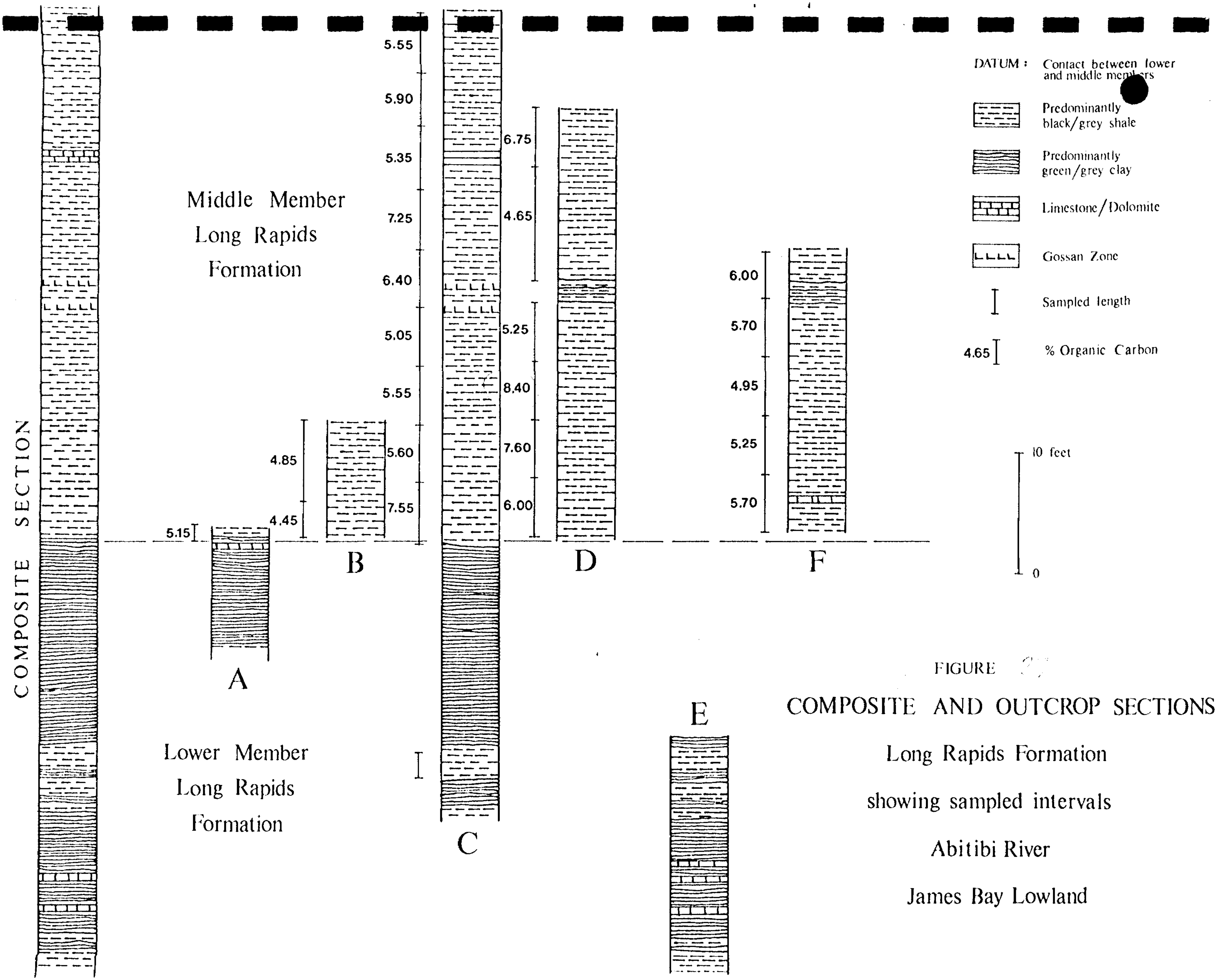
In the drillholes that penetrated the Long Rapids Formation, the informal divisions of Dyer and Crozier are easily identifiable. The intersections and thicknesses of the various members for each of the holes and for each of the 1981 holes that penetrated the Long Rapids Formation are shown in Table .

These intersections and thicknesses of Onakawana drillhole A are also provided for comparison purposes.

The range of thickness for each member is as follows:

	Feet
Upper Member	37.5–108.6
Middle Member	31.8– 97
Lower Member	30.1–120
Total Formation	100.6–285

The individual members may also abe picked out on the gamma-ray logs. There is a characteristic signature on the profile for the middle member with a number of recognizable peaks which can be traced from hole to hole. The contact between the middle member and the lower member is particularly clear on the gamma-ray logs; it



FIGURE

COMPOSITE AND OUTCROP SECTIONS

Long Rapids Formation

showing sampled intervals

Abitibi River

James Bay Lowland

TABLE

SUMMARY OF DRILLHOLE GEOLOGY

LONG RAPIDS FORMATION

HOLE	UPPER MEMBER			MIDDLE MEMBER			LOWER MEMBER			Total Thickness Intersected (ft)
	From (ft)	To (ft)	Thickness (ft)	From (ft)	To (ft)	Thickness (ft)	From (ft)	To (ft)	Thickness (ft)	
81-01	368.4	EOH	18.4	—	—	—	—	—	—	18.4
81-02	241.4	350.0 EOH	108.6	—	—	—	—	—	—	108.6
81-03	244.7	EOH	28.6	—	—	—	—	—	—	28.6
81-04	258.3	302.3	44.0	302.3	EOH	6.1	—	—	—	50.1
81-05	222.0	302.0	80.0	302.0	372.0	70.1	372.0	EOH	30.0	180.0
81-08	122.0	180.1	58.1	180.1	EOH	30.0	—	—	—	88.1
81-09	200.0	EOH	103.4	—	—	—	—	—	—	103.4
81-10	262.4	322.5 EOH	60.1	—	—	—	—	—	—	60.1
81-11	230.0	300.9	70.9	300.9	340.6	39.7	340.6	336.1 EOH	30.1	140.7
82-01	172.5	210.0	37.5	210.0	249.0	39.0	249.0	273.1	24.1	Into Williams Island (100.6)
82-04	310.0	372.0	62.0	372.0	412.0	40.0	412.0	EOH	26.9	128.6
82-05	324.0	394.0	70.0	394.0	425.8	31.8	425.8	EOH	13.2	115.0
82-18	—	—	—	327.0	382.0	55.0	382.0	EOH	28.0	83.0
Onakawana Hole A (ODM)	250.0	318.0	68.0	318.0	415.0	97.0	415.0	535.0	120.0	285.0

is characterized by a sudden decrease in the level of radioactivity. The contact between the upper member and middle member is less easy to define.

The drillcore sampling program was restricted to the middle member of the Long Rapids Formation. Representative samples, consisting of half-core were taken of this oil shale, usually over 5-foot sections, in Holes ONEX-82-01, ONEX-82-04, ONEX-82-05, and ONEX-82-18.

7.6.3 ANALYSES AND RESULTS

The material sampled and sent for analysis consisted of representative outcrop channel chips and NQ cores (1 7/8 inches in diameter) cut in half with a rock saw; one half was retained for future reference. All samples were submitted to the laboratories of Bondar–Clegg and Company Ltd. (Ottawa) where they were ~~crushed~~ prior to analysis.

At Bondar–Clegg all samples were analyzed for total organic carbon content. The crushed material was first riffled to obtain a 100 g split that was pulverized to -200 mesh (75 microns) with 1 g of pulp collected by riffling.

The pulp was then weighed and treated with hydrochloric acid in Leco crucibles to remove the mineral carbon of the carbonates. The pulp was dried and the remaining carbon (organic) was converted to CO_2 and CO by high temperature oxidation (combustion) in a Leco induction furnace. The CO_2 and CO were entrained by a purifying train into a catalytic furnace to convert the CO into CO_2. The gas then proceeded to a Leco semiautomatic gasometric carbon analyzer. The produced CO_2 was quantified against standards by an infrared detector located in the gasometer and the organic carbon content is calculated from the amount of CO_2. Reproducibility is generally at ±5% of the reported results, accuracy is in the ±3% to ±6% range, dependent on the organic carbon content and the standard used.

Results of organic carbon determination on 59 samples from the 1982 program ranged from 2.40 to 11.40%, the arithmetic average being 6.17%. Results were in the range expected from data collected in the 1981–82 initial evaluation of the oil shale and no analytical check was conducted because the 1981 analytical check showed the results of Bondar-Clegg reliable and conservative (or slightly low in accuracy of weight percents).

The total organic carbon content cannot in itself be used to evaluate the energy potential. Characterization of the organic matter may be done through pyrolysis. Pyrolysis is the chemical decomposition by the action of heat on organic matter to produce small molecules of hydrocarbon vapours, which, when cooled, give liquid and gaseous fuels. Fischer Assay is an analytical method for pyrolysis.

The rejects from 40 samples containing more than 3.29% organic carbon were sent to the Colorado School of Mines Research Institute (Denver, USA) for Fischer Assay. At the laboratory a representative 100 g of crushed material is ground to -3 mesh (6 mm). The sample is poured into a vessel (retort) with heat transfer disk placed at regular intervals within the crushed shale. The vessel is closed tightly and connected to a centrifuge tube placed in an ice water bath and to an ice water condenser. The retort is heated electrically according to a specified temperature time profile to 500°C and held at that temperature for 20 minutes. The heat decomposes the kerogen into hot hydrocarbon and water vapours that are entrained and condensed in a centrifuge tube. Upon completion of the heating treatment, the centrifuge tube is removed, warmed to 40°C, and centrifuged for 10 minutes at 2,000 rpm to separate the water from the oil. The volume of water and oil is measured and a specific gravity measurement done on a sample of oil. The weights of water, oil, and spent shale are recorded. These measurements are used to calculate the yields of oil, water, and gas plus loss in terms of US gallons per short ton and/or weight percent. The gas plus loss represents gaseous hydrocarbons, carbon monoxide and dioxide, sulphur and nitrogen gases, hydrogen, methane, etc. Left behind in the retort is solid spent shale which contains carbonaceous matter, solid hydrocarbon or coke. The amount of the organic matter left behind is proportional to the organic carbon present in the spent shale. The ratio of the organic carbon content in the spent shale (expressed as percentage of the raw shale) to the organic carbon content present originally in the raw shale gives the organic carbon conversion under pyrolysis. Organic carbon content on all samples of spent shale was determined.

Individual results of Fischer Assay on the 40 samples submitted gave: an oil yield range of 0.4 to 10.3 US gallon per short ton (0.16 to 4.06% by weight) and averaging 5.56 US gal/ton (2.20%); gas plus loss or noncondensable vapour ranging from 0.4 to 2.6% by weight and averaging 1.4%; and organic carbon conversion of 9 to 46% and averaging 29%.

Table summarizes the results of analyses for all of the samples collected in the 1980, 1981, and 1982 programs from the Long Rapids Formation. The results are grouped by townships, within township by sites, and within sites according to the geological member to which the samples belong and finally the organic carbon contents. The results shown are for organic carbon contents, Fischer Assay yields, and organic carbon conversion under Fischer Assay.

Organic carbon (OC) contents are used to arbitrarily qualify rocks in terms of: inorganic (<0.5% OC), organic-poor (0.5–1.74% OC), organic (1.75–4.39% OC), and organic-rich (>4.40% OC). There are wide variations in organic carbon contents, vertically at given sites and laterally across the region.

Vertically, the organic carbon contents show that the middle member of the Long Rapids Formation is organic-rich and made up of predominantly of black, grey, and dark brown shales with minor thin bands of greenish-grey pelite. The sampled thickness of middle member ranges from a low 31.8 feet (Hole ONEX-82-05) to a high of 70 feet (Hole ONEX-82-05). The upper and lower members are organic to organic-poor with the upper member made up of interbedded greenish-grey, soft claystone, and harder clayey shale; the lower member contains pale greenish-grey, soft claystone to grey, harder claystone with bands of dark organic-rich shale and some hard concretionary material.

Regional trends for organic carbon content are poorly understood, only the middle member was sufficiently sampled to show a trend. Highest organic carbon content are located on a northwesterly line joining Williams Island to Hole ONEX-82-05 to Holes ONEX-82-01, ONEX-82-04, and ONEX-82-05; organic content decreases to the northeast and southwest from the line. No geological exploration as yet been found to explain the organic content distribution.

TABLE

SUMMARY OF RESULTS

LONG RAPIDS FORMATION

LOCATION			SAMPLING				ORGANIC CARBON			Inorganic Carbon	FISCHER ASSAY			
											OIL YIELD			
Township	Locality	Type	From (ft)	To (ft)	Length (ft)	GEOL. MEMBER	Raw Shale (%)	Spent Shale (%)*	Conversion (%)**	Raw Shale (%)	(US gal/ short ton)	(%)	Gas + Loss (%)	Water (%)
Hobson	Williams Island	Grab	—	—	—	Middle	5.48	—	—	0.27	—	—	—	
Hobson	Williams Island	Core	4.9	11.5	6.6	"	8.85	5.79	35	0.77	8.41	3.34	2.85	5.59
	Hole LX-3	"	11.5	24.6	13.1	Lower	3.88	3.49	21	0.99	4.09	1.56	1.93	3.94
		"	24.6	27.9	3.3	"	0.74	—	—	—	—	—	—	
Hobson	Williams Island	"	19.7	21.7	2.0	Middle	0.61	—	—	—	—	—	—	—
	Hole LX-7A	"	21.7	73.8	52.1	"	7.54	4.79	36	0.58	7.95	3.09	2.24	3.71
		"	73.8	90.2	16.4	Lower	3.12	2.24	28	1.67	4.03	1.91	0.74	2.63
		"	90.2	100.1	9.9	"	5.43	3.63	33	0.79	6.23	2.51	0.63	3.13
		"	100.1	106.6	5.5	"	1.70	1.19	30	1.05	0.40	0.15	0.25	1.23
		"	106.6	116.5	9.9	"	3.90	2.39	39	1.87	6.03	2.26	0.80	2.54
	Hole LX-7A (from above)	"	57.4	73.8	16.4	Middle	7.74	5.05	35		10.24	4.02	2.20	3.42
Hobson	Abitibi River Section A	Outcrop	10.0	11.0	1.0	"	5.15	—	—	—	—	—	—	—
Hobson	Abitibi River Section B	"	0.0	3.0	3.0	"	4.45	—	—	—	—	—	—	—
		"	3.0	10.0	7.0	"	4.85	—	—	—	—	—	—	—
Hobson	Abitibi River Section C	"	23.5	68.75	45.25	"	6.02	4.71	22		2.98	1.18	1.13	9.99
Hobson	Abitibi River Section D	"	0.0	41.50	41.50	Middle	6.03	—	—	—	—	—	—	—
Hobson	Abitibi River Above Section E	Grab	—	—	—	"	6.53	—	—	—	—	—	—	—
Hobson	OEC-81-05	Core	232.9	282.2	49.3	Upper	1.19	—	—	—	—	—	—	—
		"	282.2	296.6	14.4	"	2.47	—	—	—	—	—	—	—
		"	296.6	325.8	29.2	Upper/Middle	4.65	—	—	—	—	—	—	—
		"	325.8	374.0	48.2	Middle/Lower	6.02	4.04	33	0.30	3.06	1.16	1.97	8.82
		"	374.0	401.9	27.9	Lower	2.57	—	—	—	—	—	—	—
Gardiner	OEC-81-11	"	231.6	273.0	41.4	Upper	0.93	—	—	—	—	—	—	—
		"	273.0	284.1	11.1	"	2.55	—	—	—	—	—	—	—
		"	284.1	292.2	7.9	"	1.40	—	—	—	—	—	—	—
		"	292.0	296.6	4.6	"	2.25	—	—	—	—	—	—	—
		"	296.6	301.8	5.2	"	1.38	—	—	—	—	—	—	—
		"	301.8	315.0	13.2	Middle	3.79	—	—	—	—	—	—	—
		"	315.0	321.5	6.5	"	4.68	—	—	—	—	—	—	—
		"	321.5	334.7	13.2	"	2.66	—	—	—	—	—	—	—
		"	334.7	340.6	5.9	"	5.11	3.42	33	0.35	3.14	1.16	1.62	5.44
		"	340.6	351.4	10.8	Lower	3.50	3.31	16	0.34	1.65	0.57	—	—
		"	351.4	357.9	6.5	"	3.56	4.32	22	0.20	3.42	1.30	—	—
		"	357.9	361.2	3.3	"	3.75	2.76	26	0.09	0.60	0.23	—	—
		"	361.2	366.1	4.9	"	0.98	—	—	—	—	—	—	—
Gardiner	OEC-81-08	"	149.9	160.1	10.2	Upper	1.48	—	—	—	—	—	—	—
		"	160.1	180.5	20.4	"	2.23	—	—	—	—	—	—	—
		"	180.5	211.0	30.5	Middle	3.08	2.95	20	0.63	0.97	0.37	1.49	9.03
Mulholland	OEC-81-10	"	276.3	292.7	16.4	Upper	1.24	—	—	—	—	—	—	—
		"	292.7	299.2	6.5	"	2.47	—	—	—	—	—	—	—
		"	299.2	305.8	6.4	"	0.99	—	—	—	—	—	—	—
		"	305.8	322.2	16.4	"	1.75	—	—	—	—	—	—	—
Gentles	OEC-82-01	"	210.0	250.0	40.0	Middle	7.56	5.02	34	—	8.31	3.30	1.68	4.81
Gentles	OEC-82-04	"	358.0	372.0	14.0	Upper	2.65	—	—	—	—	—	—	—
		"	372.0	412.0	40.0	Middle	7.64	5.22	32	—	7.78	3.00	1.43	5.11
Gentles	OEC-82-05	"	402.0	426.0	24.0	"	7.88	4.85	38	—	7.85	3.11	1.94	5.06
McCausland	OEC-82-18	"	330.0	335.0	5.0	"	5.50	4.12	25	—	2.9	1.15	1.80	5.76
		"	335.0	355.0	20.0	"	3.62	3.20	12	—	1.2	0.51	0.83	7.91
		"	355.0	382.0	27.0	"	5.09	4.14	19	—	3.55	1.41	0.99	6.72

Fischer Assay was performed on a total of 104 samples collected in 1981 and 1982; work was concentrated on the organic-rich middle member with 81 samples assayed, only 23 samples of the middle member were assayed and no sample of the upper member of the Long Rapids Formation were submitted because of their low organic carbon contents.

Results of Fischer Assay, with their oil, gas and water yields, and organic carbon conversions, indicate large variations in terms of organic matter types and contents. Best results were obtained from the cores of Hole LX-7A, and OEC-82-01, OEC-82-04, and OEC-82-05, where the middle member is 24 to 48.2 feet in thickness and yielded: 7.8 to 8.3 US gallons per short ton (3.0 to 3.3% by weight) of shale oil, 1.4 to 1.7% by weight noncondensable gases, and 3.7 to 5.1% water; the organic carbon conversion in those holes ranged from 32 to 38%. The best results coincide with the richer organic carbon northwest oriented trend; elsewhere the middle member yielded 1.0 to 3.1 US gallons per short ton oil (0.4 to 1.2%), 1.0 to 2.0% gas and 5.4 to 10.0% water, organic carbon conversion was 17 to 33%.

7.6.4 CONCLUSION AND RECOMMENDATION

The Long Rapids Formation in the Moose River Basin contains oil shales in its middle member, which is known to have a thickness in the range of 31.8–97.0 feet. Organic carbon determinations and Fischer Assays (or pyrolysis) for hydrocarbon yields show a wide variation.

The testing programs (1981 and 1982) indicate that the northwest oriented trend from Williams Island appears to have the highest potential for oil shale based on organic matter content and quality (higher atomic hydrogen to carbon ratio). The trend shows an oil shale zone about 30 feet thick capable of yielding some 8 US gallons per short ton (3.1%) shale oil and 2% low- to high-energy gases at an organic carbon conversion rate of 36%.

A more efficient conversion rate by hydrogenation method would at least double the hydrocarbon yields.

It is recommended that a low density borehole program be implemented throughout the Moose River Basin to better evaluate the oil shale potential of the Long Rapids Formation. If successful in delineating sufficient tonnage of equal or better quality shale, the program should be expanded to test process for the recovery of synfuel from those shales for which a recoverable shale oil resource potential of 20,000 million barrels was estimated in another report (WGM 1982).

7.6.4 CONCLUSIONS AND RECOMMENDATIONS

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It is recommended that a reconnaissance borehole program be implemented throughout the Moose River Basin to better evaluate the oil shale potential of the Long Rapids Formation. If successful in delineating sufficient shale tonnage of equal or better quality, the program should be expanded to test processes for the recovery of synfuel from those shales. A recoverable shale oil resource potential of 20,000 million barrels has been estimated in another WGM report (in preparation).

7.7 OTHER COMMODITIES

Other commodities of possible economic significance in the vicinity of the licence area include peat, limestone, and gypsum. These were discussed in the WGM 1981 lignite report; only a few general comments will be included here.

The James Bay Lowland is covered by virtually continuous peat bogs. No systematic evaluation of these peat lands has been carried out, although the Ontario Ministry of Natural Resources has an ongoing remote-sensing program that will be providing peat classification maps of the region. The 1981 lignite program also included limited examination of a few extensive bogs in the eastern part of the OEC licence area. No effort was made in 1982 to evaluate the peat bogs in the western and central portions of the licence area, which contain extensive and probably relatively thick (4–8 feet) bogs. Figure 27 (subsection 7.2.3) illustrates typical bogs in the central part of the licence area. The northern climate and distance from large markets precludes development of these vast peat resources for some time. However, recent improvements in techniques in the mining and treatment of wet peat may improve the economics of a major peat mining project, especially in areas near the Ontario Northland Railway. Certainly, the economic viability of such an operation would be greatly improved if large lignite and/or industrial mineral operations were to develop in the area.

Limestone beds occur in several Devonian formations, but the most extensive units are associated with the Williams Island Formation. Widespread exposures occur in the vicinity of Grand Rapids on the Mattagami River, and of course at Williams Island on the Abitibi River. An analysis (Bennett et al. 1967, p. 88) of a limestone from Coral Rapids on the Abitibi River indicated a very high calcium and low magnesium content.

Exposures of gypsum are found in a 40-mile long, northwest-trending belt in the area of Moose River Crossing. These consist largely of white, massive, gypsum occuring in beds from a few feet to as much as 90 feet thick. Some drilling of these units was done in the northern part of the belt in 1963 (Bennett et al. 1967), but the results of this work are presently unavailable.

None of these commodities are likely to be of economic importance in the near future; on their own, they may not be economically viable in the forseeable future, because of their remote location and the lack of a well-developed infrastructure in the region. However, if a large energy-based mining and processing operation were to be developed in the region, then the economics of establishing other energy-intensive operations would change dramatically. The presence of an established railway system in the area and the possibility of building a port facility at Moosonee would greatly enhance access to foreign, domestic, and northern US markets.

Any major developments in this region are likely to hinge on establishing large lignite reserves that will justify a major mining operation. In future development plans, special attention should be directed towards exploiting the considerable potential of the many industrial commodities in the James Bay Lowland.

8. GENERAL CONCLUSIONS

The 1982 exploration program was a success in both a technical and non-technical sense. Drilling, using reverse-circulation and triple-tube coring, was quite effective, and the combination is probably the most efficient for a helicopter-supported program. However, it is hoped that depth capabilities (approximately 400 feet) of the reverse-circulation system can be improved in future operations. The Acker P38 drill, utilizing a 10-foot overhead stroke, is a very good rig for both reverse-circulation and coring. It can be easily adapted to a helicopter-supported project, and is probably more efficient than traditional drill systems using a standard 3-foot stroke.

Wireline geophysical logging appears to be a useful tool, especially in combination with reverse-circulation drilling. In almost all cases, it is necessary to case the drillholes with heavy-duty plastic casing in order to support the hole walls. It also appears that using the natural gamma, neutron, and density logs is an effective combination, and the sensitivity of each of these systems is affected very little by the plastic casing.

The Astar 350D helicopter has been shown to be very suitable for supporting drill programs. This aircraft is relatively new and has had a few "teething" problems; but with good maintenance, it is a reliable machine. Its size and lifting capabilities are comparable to a Bell 206 Long Ranger.

The lignite potential in the James Bay Lowland has been greatly enhanced by the 1982 drill program. Two new important discoveries, one west of Gentles Township and the second in southern McBrien Township, attest to the need for a systematic regional drill program. The 1981 and 1982 discoveries in the vicinity of Gentles Township certainly confirm the potential for discovering significant lignite deposits north of the Missinaibi River.

Although the 1981 lignite discovery lies at depths suitable for open-pit mining, the 1982 discoveries are probably too deep (over 200 feet) for mining by conventional methods. Other means of tapping the energy potential of these occurrences must be carefully evaluated.

The new lignite discoveries have some relatively thick seams (15–22 feet) and analyses of selected samples have yielded high heat values. However, many of the lignite samples contain substantial clay and sulphur (mainly pyrite), both of which reduce the energy potential of the fossil fuel. The only trace element in the lignite ash of possible economic significance is platinum, which may occur in recoverable amounts.

An evaluation of the sedimentary environment of the lignite occurrences suggests they are associated with vertically accreting river channels. In this environment, the thickest lignites would probably occur behind the river levees, where forestation would be dense; or along the margins of the basin, where thick swamps could develop without being reworked by meandering streams. Between the main river channels there are likely to be thin, blanket-like swamps where lignite (originally peat) could develop. In many respects, this sedimentary environment was perhaps not unlike the modern James Bay Lowland, although during the Middle Albian (100 m.y. B.P.) when the lignites were being formed, the regional climate was probably warmer.

Silica sands are widespread in most of the Cretaceous Basin, although they appear to be especially abundant in the western part of the original licence area. The sands are quartzose and variable in grain size. Many of the occurrences are over 20 feet thick and appear to be laterally extensive. Size and composition analyses of these sands indicate that they would suit many industrial purposes.

Most of the Cretaceous sands and lignites are interbedded with a variety of clay beds. In the work carried out in 1982, very few of the clay occurrences appear to be suitable for high-quality coating purposes, but they would be suitable for many other industrial demands. The light grey to white clays are predominantly kaolin and often occur in thin discrete beds and/or as a persistent matrix component in many of the quartz sand beds. The potential for higher-grade clays in the Cretaceous Basin is good.

Concentration of heavy minerals from clastic units can be an effective exploration tool in an area where bedrock exposures are limited. In the 1982 program, the heavy-mineral concentrates yielded only one significant anomaly: a concentration of pyrope garnet in a Cretaceous sand. This type of garnet is an important indicator-mineral for kimberlite; its apparently localized distribution suggests that the channel-sand host may have been derived from a small stream, the drainage of which intersected a previously exposed kimberlite. The paleo-channel may have been draining from off the Grand Rapids Arch, which appears to have been an elevated area during much of the Cretaceous period.

The Long Rapids Formation of Middle Devonian age contains beds of oil shale with considerable economic potential. The oil shale beds are not exposed everywhere beneath the Cretaceous units but they are well documented in parts of Gentles Township as well as much farther west in McCausland Township. Fischer Assays yielded oil in the range 7–8 US gal/short ton over thicknesses of several tens of feet. Although these results are certainly too low to be considered economically significant in today's market conditions, the Long Rapids Formation oil shales could be a future energy resource.

Peat bogs cover most of the James Bay Lowland. The bogs are up to 6–8 feet thick and of good quality. They contain about 90% water, but when dried out they yield high heat values. The northern climate may not favour drying peat on-site; it is probable that their energy potential would best be realized by a wet mining and processing scheme that will upgrade the end-product. The economic viability of a peat mining operation would be much improved if there were other major industrial operations in the immediate region.

Other commodities of possible economic interest in the region include gypsum (exposed near Moose River) and limestone that occurs in several of the Devonian formations (best exposed in the vicinity of Grand Rapids in the Mattagami River, and Williams Island in the Abitibi River). These industrial commodities are close to the Ontario Northland Railway and, as in the case of the peat resources, could be economically important, when or if major projects nearby justify the development of an infrastructure suitable for use by other smaller, more marginal projects.

9. RECOMMENDATIONS

The following general recommendations are made for further exploration and evaluation work in the James Bay Lowland:

1. The successful drill programs in 1981 and 1982 strongly indicate the need to continue reconnaissance drilling for lignite in the licence area. This drilling should be concentrated in the larger northern block (Part A of Map 1) of the new licence area. Most of the drilling should be carried out in southern Mahoney, Lambert, Rapley, and southern Gentles Townships. Drillhole should be spaced at approximately 5 km; approximately 20 reconnaissance holes are required to cover this region adequately.

2. More detailed drilling should be carried out in the immediate vicinity of the 1981 and 1982 lignite discoveries to better define the geometry and extent of these occurrences. The holes should be only 2–3 km apart. Approximately six holes are recommended surrounding each of the occurrences in Gentles, West Gentles, and McBrien Townships.

3. The pyrope anomaly in Hole ONEX-82-03 in the southeastern corner of McCuaig Township certainly warrants follow-up drilling. Initially, the anomaly should be verified by redrilling; the zone of interest should be cored if at all possible, to evaluate its stratigraphic and sedimentological characteristics. After coring is completed, the rods should be switched to the reverse-circulation system and a large sample (approximately 1 tonne) be taken from the anomalous one. Should the anomaly be fully verified, a substantially large bulk sample should be taken and a closely spaced step-out drilling program be carried out.

4. Several of the drillholes in the regional program should be deepened if they intersect the Long Rapids Formation. Sections of this formation should be cored: organic carbon content and Fischer Assay tests should be carried out on selected ones. If these tests are encouraging, then preconcentration and oil recovery tests should be considered.

5. Any drilling in the region should be carefully logged and sampled to define silica sands and clays that could be of possible economic importance. Routine test-work should determine the possible industrial applications that these commodities could meet.

6. Heavy mineral analyses should be routinely carried out on all Cretaceous and Pleistocene clastic units. The main target for this work is diamond or kimberlite indicator-minerals, but a variety of metals should also be carefully checked-for.

7. Schemes to harness the energy-potential of the lignite, as well as to recover other commodities such as silica sand, clay, gypsum, and peat should be examined more carefully. Application of the borehole-slurry mining system to the lignite deposits should be carefully evaluated; and if the evaluation is encouraging, then a large-scale pilot test would be warranted. This test-work could qualify for financial assistance from provincial and/or federal government agencies.

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Watts, Griffis and McOuat Limited

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SUMMARY REPORT ON THE 1982 EXPLORATION PROGRAM IN THE JAMES BAY LOWLAND

DRILL AND GEOPHYSICAL LOGS
VOLUME II

Toronto, Canada
December 16, 1982

Watts, Griffis and McOuat Limited
Consulting Geologists and Engineers

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

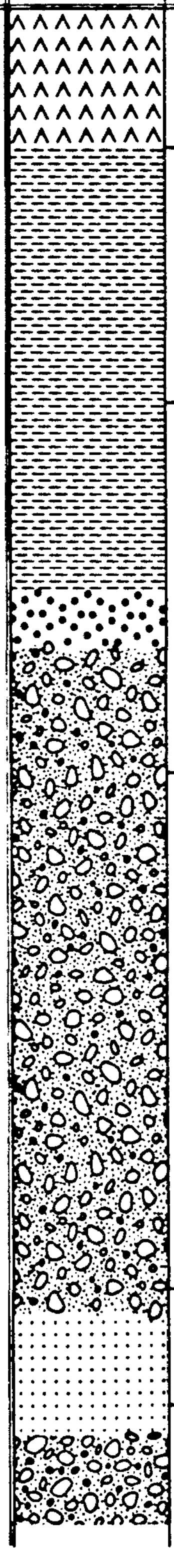
Drill Hole Nº: ONEX-82-01 Location: East Central Gentles Tp

Elev. of collar: 285 ft Sheet 1 of 5 (lat. 50°33'06"N long. 81°56'04"W)

DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description

DEPTH m: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

DEPTH ft: 5 10 15 20 25 30 35 40 45 50 55 60 65



Sampling Number: 82-001, 82-002, 82-003, 82-004

RECENT / PLEIST.

MUSKEG: 0-6.0'

MARINE CLAYS: 6.0-25.0'
Medium grey, clayey with sedimentary and basement pebbles and fragments of cobbles. Some shell fragments associated with clay.
Gritty intervals dominantly light coloured with sedimentary pebbles.

GRAVEL: 25.0-27.0'
Pebbles and cobbles of sedimentary and mafic materials.

TILL: 27.0-56.0'

27.0':	Gritty clay till. Few pebbles.
29.0':	Stiff calcareous clay. Occasional cobble.
32.0':	Slightly gritty clay. Rare pebbles and cobbles.
46.0':	Light grey-green clay with rare detrital lignite.
47.0-48.0':	More gritty with pebbles.
54.0':	Clay is darker grey-green colour.
55.0':	Thin sandy unit.

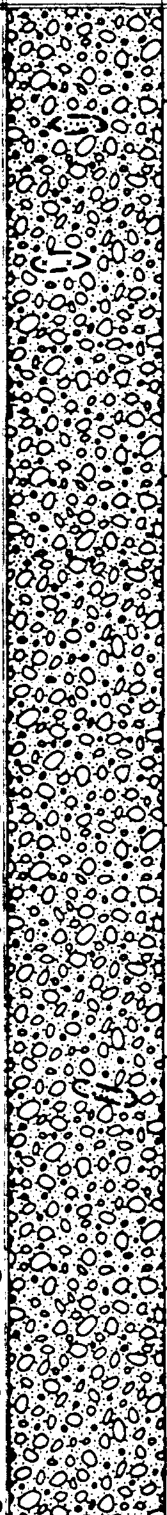
SAND: 56.0-61.0'
Polymictic grey sand.

TILL: 61.0-110.0'

61.0-62.0':	Green-grey clay, sand and pebbles.
62.0-67.5':	Light grey. Clay, fine sand and pebbles of sedimentary and basement rock. Some sand seems immature. Some cobbles present.

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

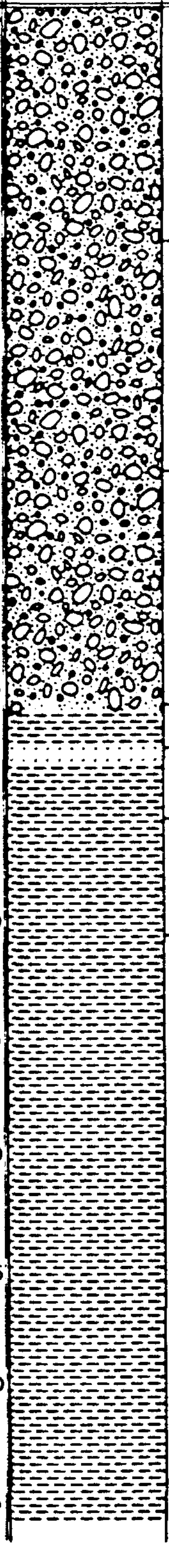
Drill Hole Nº: ONEX-82-01

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
20	65					67.5-69.0': More pebbles. Less sand.
21	70					69.0': Clay content increases.
22						72.0': Material becoming coarser. Less clay. Basement fragments predominate rock type.
						73.0-74.0': Sedimentary boulder.
23	75					74.0-83.0': As above. Fine sand increases. Little clay.
24					82-005	77.0': Boulder. Diabase?
25	80					83.0-110.0': As above. Clay content increases. Pebbles and cobbles present.
26	85					
27	90					
28					82-006	
29	95					
30						
31	100					
32	105				82-007	
33						SANDY TILL: *110.0-160.0'* Sandy-cobble-boulder till. Occasional chips of detrital lignite.
34	110					113.0': Tan sedimentary boulder.
35	115				82-008	
36						
37	120			C.S.		
38	125				82-009	
39						
40	130					

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX 82-01

Sheet 3 of 5

DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
40–60	130–195			CRETAC. / DEVON.; C.S.; 50	82-010, 82-011, 82-012, 82-013, 82-014, 82-015	see below

Description

132.0': Increased quartz content. Sedimentary and basement fragments. Minor detrital lignite.

138.0': Trace of small lignite fragments.

155.0': Shale fragments.

CLAY: 160.0-161.5'
Light grey. Trace grit.

PLEIST. / CRETAC.

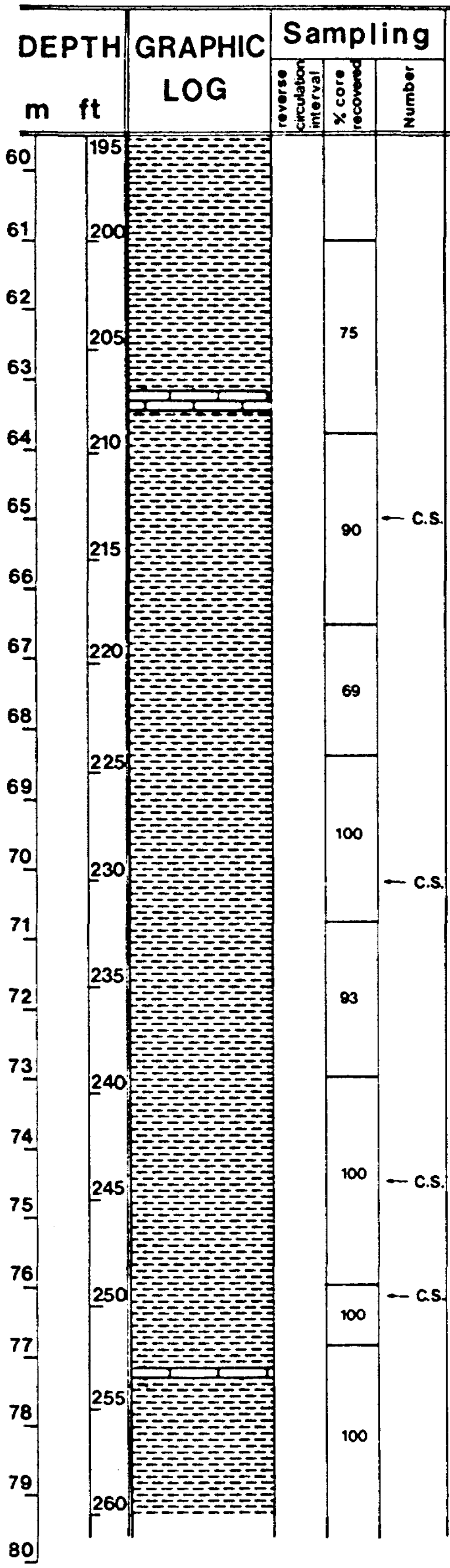
SAND: 161.5-162.0'
Minor lignite.

CARBONACEOUS CLAY: 162.0-172.5'
Gritty and stiff. Thin lignite seams(?) between 164.0-169.0'.
170.0-172.5': Increased sand content.
172.5': ½" grey-green micaceous sand.

DEVONIAN CLAYS: 172.5-292.0'
172.5-175.3': Green-grey silty clay. Occasional thin (<¼") sand layers. Minor mica. Noncalcareous.
175.3': 0.2" dark grey silty to sandy clay.
175.5-181.0': Alternating thin bands of chocolate brown silty clay and green-grey clay. Occasional pebble. Unit also has small blebs and stringers of pyrite. <1% total. Mildly calcareous over portions of interval.
181.0-181.7': Green-grey sandy clay.
181.7-191.0': Same as 175.5-181.0'.
191.0-192.0': Light grey-green limestone.
192.0-200.0': Dark grey-green calcareous clay with light green spots and clay layers scattered throughout. Non-pyritic.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-01



Description

200.0-207.0': Chocolate brown compact silty clay with chocolate brown clay layers. Noncalcareous. Pyritiferous with blebs to ½". Most pyrite finely disseminated. Interbeds of grey-green calcareous clay with limestone pebbles and clasts. Occasional sedimentary features.

207.0-207.5': Medium grey limestone.

207.5-209.0': Same as 200.0-207.0'.

209.0-218.0': Dark grey-black carbonaceous shale. Fissile, crumbly in places. Blebs of pyrite throughout interval. Noncalcareous.

210.0': ½" pyrite layer. Calcareous. Dark grey clay matrix.

213.0': Several lighter coloured bands of shale.

218.0-249.5': Chocolate brown compact claystone. Shaley in places. Several 1.0-2.0' calcareous intervals. Jointing in claystone ≃30°/core axis. Unit has stringers and blebs of pyrite, especially between 225.0-232.0'. Minor limestone layers and occasional clasts 218.5', 219.5', 246.0'.

249.0-253.5': Interlayered light green calcareous clay ¼-4" thick and chocolate brown claystone ¼-6" thick.

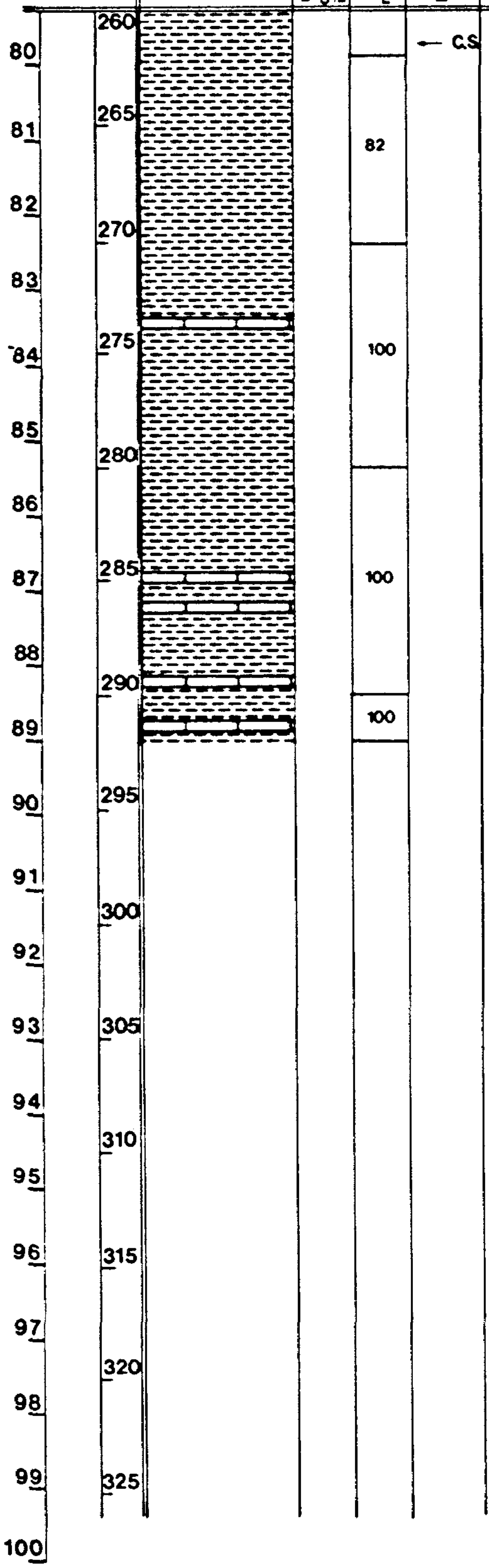
253.5-254.8': Limestone with calcite crystals in cavities.

254.8-262.0': Same as 218.0-249.5'.

257.0': 3" shaley interval.

Drill Hole Nº: ONEX-82-01

DEPTH (m: 80–100; ft: 260–325) | GRAPHIC LOG | Sampling (reverse circulation interval; % core recovered: 82, 100, 100, 100; Number: ← C.S)



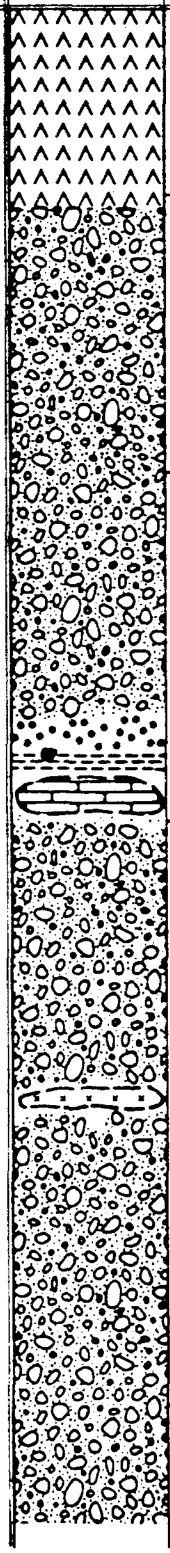
Description

Depth	Description
262.0-273.2':	Interlayered medium grey, thinly laminated, calcareous clay and light-medium grey-green calcareous clay. Disseminated pyrite 271.0-273.2'.
273.1-273.7':	Light grey limestone with disseminated pyrite. Fossiliferous. Possibly marine ostracods and pelecypods.
273.7-280.8':	Light grey-green pyritiferous clay interbedded with dark brown laminated calcareous claystone with disseminated pyrite.
280.8-281.0':	Light grey limestone. Contains cavities with drussey calcite and pyrite. Marine pelecypod at 281.0' with possible calcite rim cement.
281.0-284.5'	Pale grey, very soft calcareous clay with some thin interbedded limestones.
284.5-285.1':	Light grey limestone. Possible minor brecciation. Pyrite blebs at 285.0'.
285.1-285.3':	Medium grey stiff clay. Calcareous.
285.3-285.5':	Light green-grey limestone with pyrite.
285.5-285.8':	Chocolate brown claystone. Laminae evident. Calcite occurs in lighter laminae.
285.8-286.6':	Medium green-grey stiff clay. Calcareous.
286.6-287.1':	Green-grey limestone. Fossiliferous limestone (biosparite).
287.1-288.3':	Medium brown-grey calcareous claystone with calcite veinlets; fossiliferous (biomicrite).
288.3-288.8':	Light grey fossiliferous limestone. Some pelecypods. Some calcite veinlets. Possible laminae. Pyrite blebs and minor recrystallized calcite evident.
288.8-291.1':	Medium grey calcareous claystone. Fossiliferous. Limestone interbeds ≈290.0'.
291.1-291.6':	Light grey fossiliferous limestone (biomicrite). Contains ostracods; some laminae evident.
291.6-292.0':	Medium grey fossiliferous claystone.
292.0':	END OF HOLE

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-02 Location: Central Pickett Tp

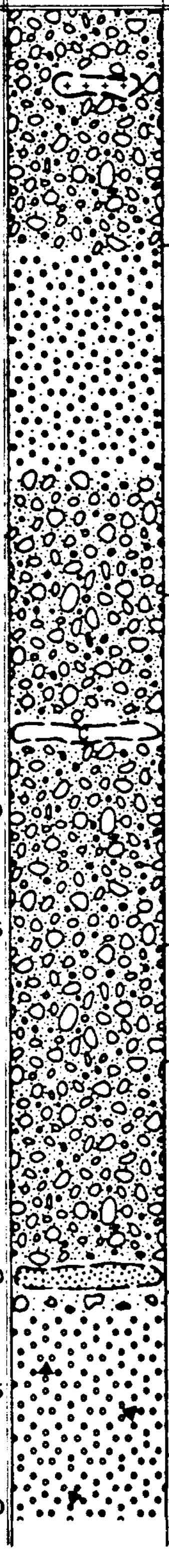
Elev. of collar: 250 ft Sheet 1 of 5 (lat. 50°35'14"N long. 80°50'15"W)



DEPTH m	DEPTH ft	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
1					MUSKEG: 0-8.0'
	5				
2			RECENT		
3	10		PLEIST.		CLAY TILL: 8.0-58.0' Light green-grey clay. Slightly calcareous. Occasional gritty intervals. Minor amount of sedimentary and basement rock fragments.
4				82-016	
	15				
5					
6	20		C.S.		
7					
	25				
8				82-017	
9	30				30.0-31.0': Gravel.
10					33.0-35.0': Boulder-limestone.
	35				
11			C.S.		
12	40				
13					
	45				
14				82-018	46.0': Boulder-basement (diabase).
15	50				
16					
	55				
17					
18	60		C.S.		CLAY SAND TILL: 58.0-75.0' Light grey-green clay. Higher grit content than 8.0-58.0'. 61.0-62.0': Pebble layer.
19					
	65				
20					

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

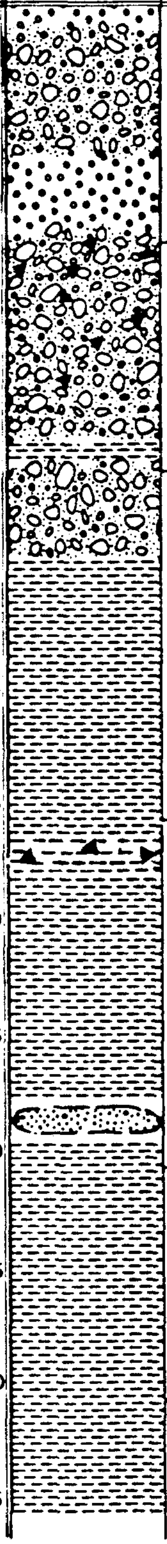
Drill Hole Nº: ONEX-82-02

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
20	65					67.0': Boulder-basement.
21	70				82-019	
22						
23	75			← C.S.		SANDY GRAVEL: 75.0-84.0' Unit is dominantly sand.
24	80					
25					82-020	
26	85					SANDY TILL: 84.0-120.0' Light green sand with pebbles and cobbles. Rocks are 30% basement and 70% sedimentary.
27	90			← C.S.		
28						
29	95					95.0': Boulder-chert.
30	100				82-021	99.0': Abundant wood chips.
31						
32	105					105.0-118.0': Minor detrital lignite (up to 15% at 107.0').
33	110			← C.S.	82-022	
34						
35	115				82-023	
36	120					118.0': Boulder-sedimentary.
37				← C.S.		PEBBLE GRAVEL: 120.0-130.0'
38	125				82-024	123.0-127.0': Coarse fragments of lignite.
39				← C.S.		
40	130					SANDY TILL: 130.0-135.0'

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-02

Sheet 3 of 5

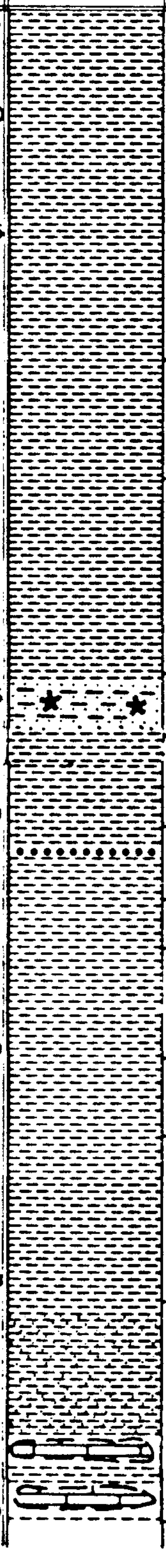
DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
40–41	130–135					
41–42	135–138				82-025	SAND AND GRAVEL: 135.0-139.0' 138.0-139.0': Minor detrital lignite.
42–43	139–140					SANDY TILL: 139.0-150.0' 139.0-140.0': Minor detrital lignite.
44	143–145				82-026	143.0-145.0': Minor detrital lignite. 145.0': Boulder.
45	148–149					148.0-149.0': Clay layer. Gritty, calcareous.
46	150–153			←C.S. PLEIST.		CLAY TILL: 150.0-153.0' Light green-grey clay, moderately stiff. Some subangular fragments.
47–48	153–157.5			CRETAC.	82-027	VARIEGATED CLAYS: 153.0-223.7' 153.0-157.5': Light-medium grey clay with yellow mottling; noncalcareous; non-gritty; moderately stiff; occasional subangular fragments.
49–51	157.5–170			←C.S.		157.5-170.0': Medium-dark grey clay with gritty layers; noncalcareous; moderately stiff. Pyrite occurs as disseminated blebs and thin layers. Minor lignite and organic debris 167.5-170.0'. Cobble at 165.0'.
52	170–178					170.0-178.0': Light grey-green clay with yellow mottling; noncalcareous; soft.
53	174.5–175			←C.S.	82-028	174.5-175.0': Contains ≈25% pyrite blebs.
54	177–178					177.0-178.0': Boulder. Sedimentary.
54–58	178–191			←C.S.	82-029	178.0-191.0': Green-grey-brownish clay with yellow and red mottling; noncalcareous; slightly gritty. Small boulder at 182.0' and 183.0'. Thin claystones at 186.0-188.0'.
58–60	191–195					191.0-214.0': Light-medium green-grey clay with red mottling; noncalcareous; slightly gritty. Few intervals with ≈5% basic rock fragments. Minor pyrite at 191.0-192.0'. Large cobble at 210.0'.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº ONEX - 82-02

Sheet 4 of 5

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description



Depth scale: m 60–80; ft 195–260

Sample numbers: 82-030, 82-031, 82-032, 82-033, 82-034, 82-035, 82-036, 82-037, 82-038, 82-039, 82-040

214.0-223.7': Red and green mottled clays; soft; non-calcareous; non-gritty.

SAND WITH CLAY: 223.7-226.0'
Green clay with fine- to medium-grained sand (80% quartz and white chert). Clay has dark, coarse- to pebble-sized rock fragments (pyrite).

VARIAGATED CLAY: 226.0-257.0'
Green, yellow, red, grey, and green-grey clay with minor mottling in places; noncalcareous with minor lignite at 227.0' and 231.0'.

250.0-255.0': Minor fine white sand imparts gritty texture to clay.

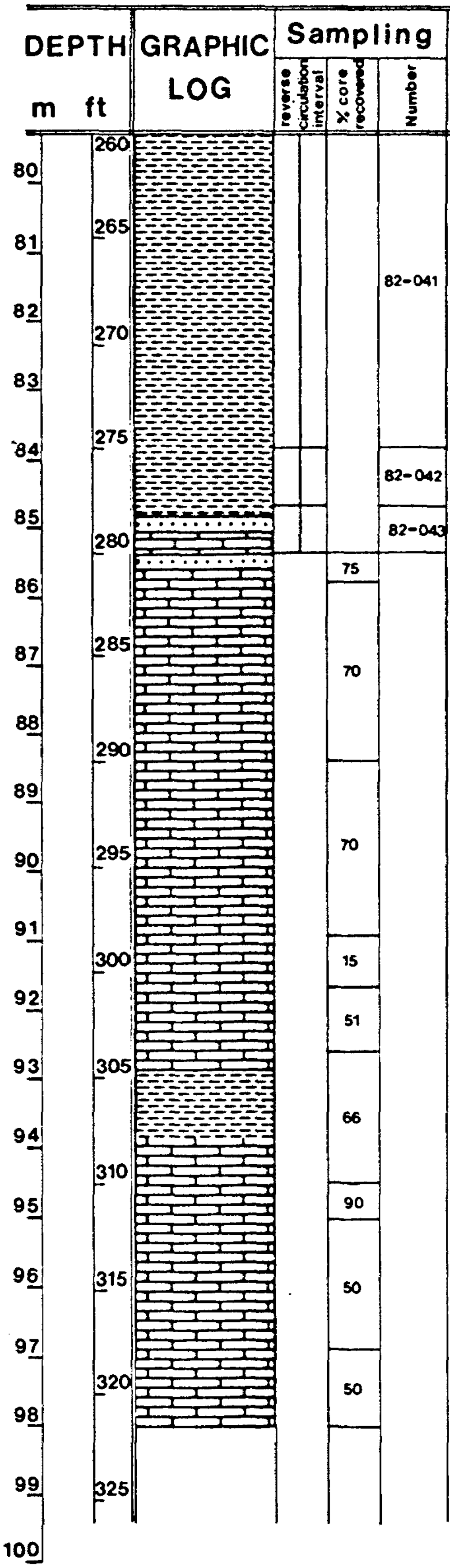
256.0': Limestone boulder.

CLAY: 257.0-258.5'
Medium green-grey clay with fine sand. Contains sedimentary rock fragments.

258.0': Boulder-limestone.

Drill Hole Nº: ONEX-82-02

Sheet 5 of 5



Description

VARIAGATED CLAY: 258.5-273.5'
Grey-green and dark grey clays with red mottling; noncalcareous; minor grit in a few thin zones; several limestone cobbles at 264.2' and 269.0'.

273.5-275.5': Medium to dark blue clay with red and purple mottling; noncalcareous; stiff; very gritty.

CLAY: 275.5-277.5'
Light green; calcareous; soft; minor grit; minor lignite at 275.5-276.5'; clay has minor pyrite.

CRETAC.
DEVON.

TRANSITIONAL: 277.5-280.0'
Thin layers of siltstone, limestone, and chocolate brown clay. H_2S gas reported at 278.0'.

LIMESTONE: 280.0-322.0'

280.0-281.5': Medium grey; vuggy.
281.5-283.8': Breccia with vuggy intervals.
283.8-296.0': Fine- to medium-grained, banded; tan-beige with thinner dark bands; pyritiferous; numerous vugs.

296.0-297.2': Medium grey with large connecting vugs; pyrite blebs to ¼".
297.2-304.0': Very fine-grained; tan-beige with several banded intervals; vuggy.

CLAY: 304.0-307.0'
Dark grey clay; calcareous with limestone fragments.

LIMESTONE: 307.0-309.0'
Medium-grained tan-grey with numerous small vugs. Grades down to fine-grained tan-beige banded limestone.

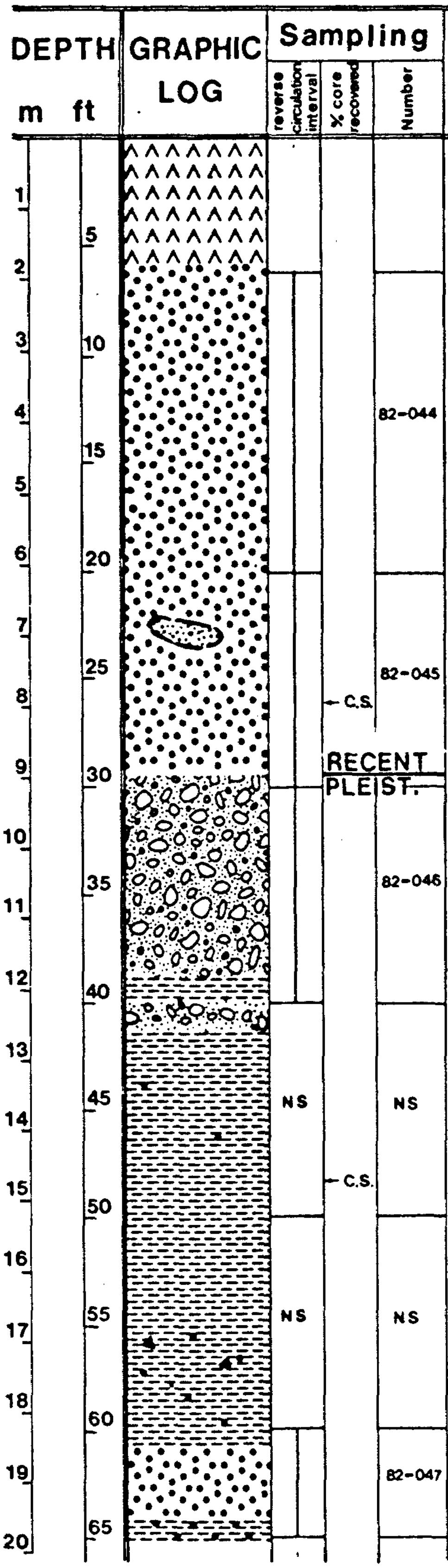
LIMESTONE AND CLAY: 309.0-322.0'
Limestone fragments filled with grey clay.

322.0': END OF HOLE

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-03 Location: Southeast McCuaig Tp

Elev. of collar: 235 ft Sheet 1 of 5 (lat. 50°34'32"N long. 81°55'39"W)



Description

MUSKEG: 0-6.0'

GRAVEL: 6.0-9.0'
Pebbles and sand.

SAND: 9.0-17.0'
Fine sand.

PEBBLY SAND: 17.0-28.0'
Pebbles and fine- to coarse-grained sand.

23.0': Sedimentary boulder.

TILL: 28.0-38.0'
Clay and sandy matrix; small pebbles with 20% basement and 80% sedimentary.

CLAY: 38.0-40.0'
Green-grey clay; calcareous.

CLAY TILL: 40.0-41.0'
Green-grey clay with small pebbles.

CLAY: 41.0-51.0'
Calcareous green-grey clay with rare sedimentary pebbles.

47.0': Clay only slightly calcareous.

CLAY: 51.0-56.0'
Darker green-brown-grey slightly calcareous clay becoming noncalcareous by 53.0'.

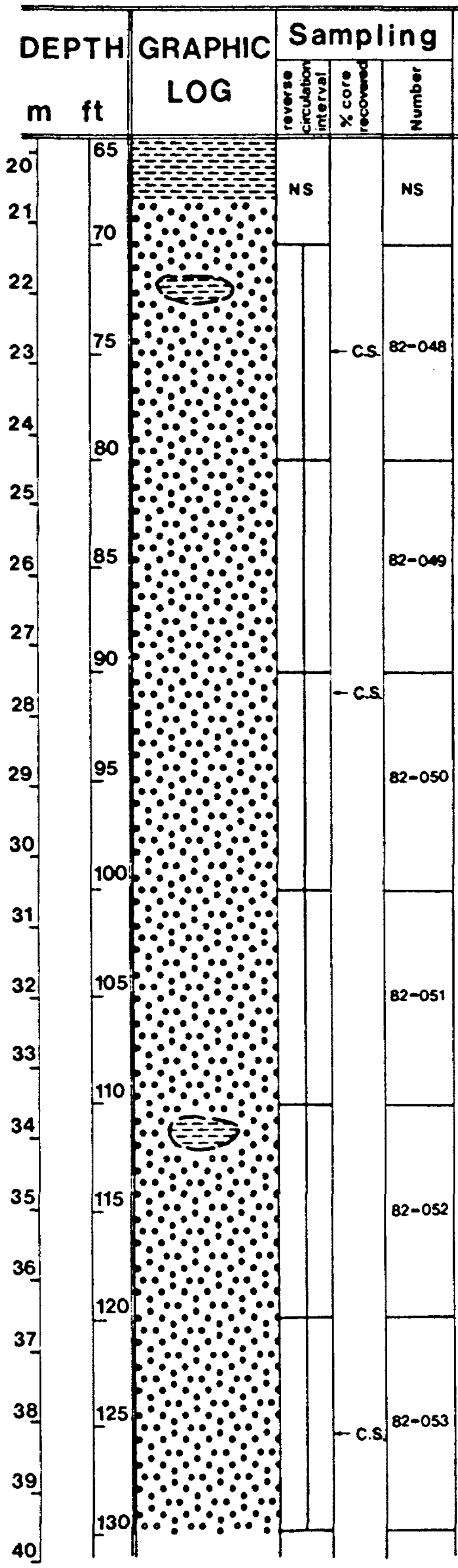
TRANSITION: 56.0-61.0'
Green-grey calcareous clay with sand. Pebbles and wood chips occur from 57.0-57.5'. Sandy clay from 57.5-61.0'; extremely calcareous with few angular pebbles; interbedded grey-green calcareous clay.

GRAVEL: 61.0-64.0'
Basement and sedimentary fragments.

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-03

Sheet 2 of 5



Description

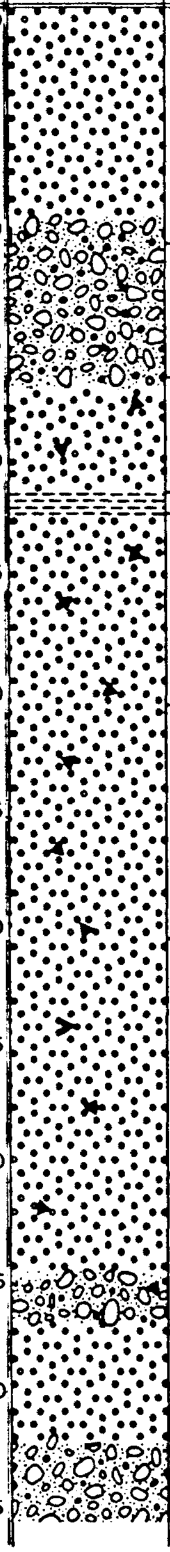
CLAY: 64.0-68.0'
Green-grey sandy clay; slightly calcareous. Dark brown wood chips appear at 65.0'.

GRAVEL: 68.0-138.0'
Sandy gravel with basement and sedimentary pebbles.
72.0': Claystone boulder.

111.0': Claystone boulder.

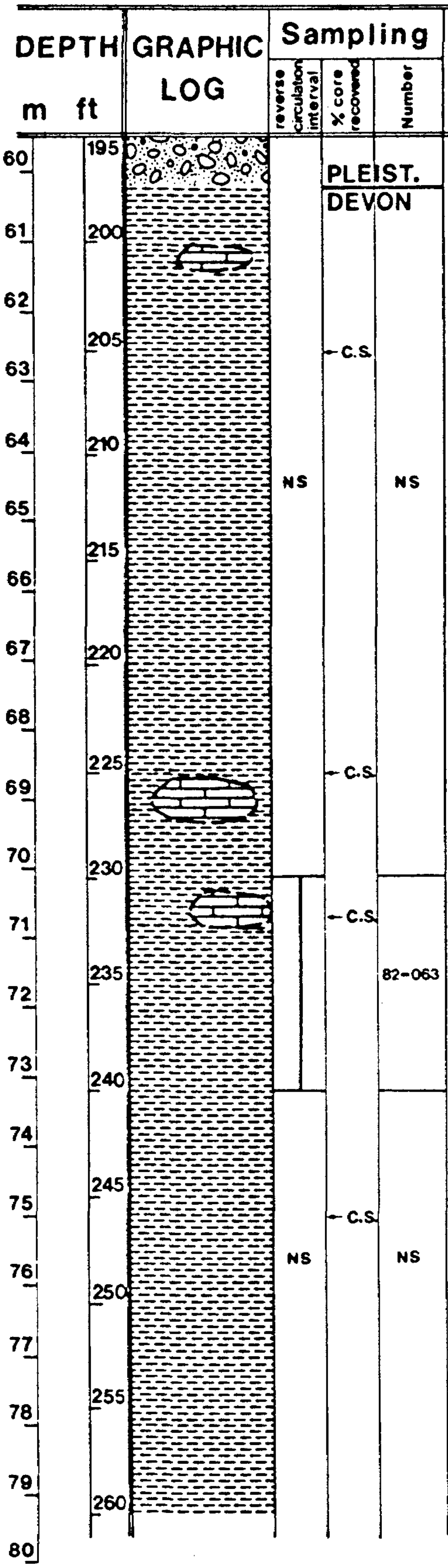
1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-03

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
40	130					
41	135				82-055	134.0': Basement boulder.
42						SANDY PEBBLY TILL: 138.0-146.0' Light green-grey clay matrix.
43	140				82-056	
44	145			C.S.		
45					82-057	GRAVEL: 146.0-151.0' Pebbly and sandy intervals with a trace amount of lignite.
46	150				82-058	CLAY: 151.0-152.0' Green grey clay.
47	155				82-059	GRAVEL: 152.0-184.0' As above.
48						
49	160					
50	165				82-060	
51						
52	170			C.S.		
53	175				82-061	
54						
55	180					
56	185				82-062	SANDY PEBBLY TILL: 184.0-186.0' Same as above with trace lignite. GRAVEL: 186.0-191.0' Same as 146.0-151.0'.
57						
58	190					
59	195			C.S.		CLAYEY PEBBLY TILL: 191.0-197.0' Grey gritty clay matrix; ≈10% lignite; 20% white chert; 35% basement, 15% limestone, 10% quartz (subangular). Minor polymictic sand.
60						

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-03



Description

CLAY: 197.0-225.0'
Dominantly light green, non-gritty to gritty, soft to stiff clay. Slightly calcareous at outset, becoming noncalcareous by 201.5'. Minor red-brown clay interbeds and mottling. Limestone boulder(?) at 201.0-201.5'.

CLAY WITH LIMESTONE CLASTS(?): 225.0-232.0'
Light green limestone integrated with light green and dark brown, soft to stiff, noncalcareous clay. Source and character of limestone is not fully understood.
229.0': Possibly the edge of a boulder.

CLAY: 232.0-265.5'
Alternating layers of light green, tan, red, and chocolate brown clays; calcareous, soft to stiff, and slightly gritty. Occasional limestone clasts appear at 242.0'; whereas, sandstone clasts occur infrequently at 248.0' and 258.0'.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-03

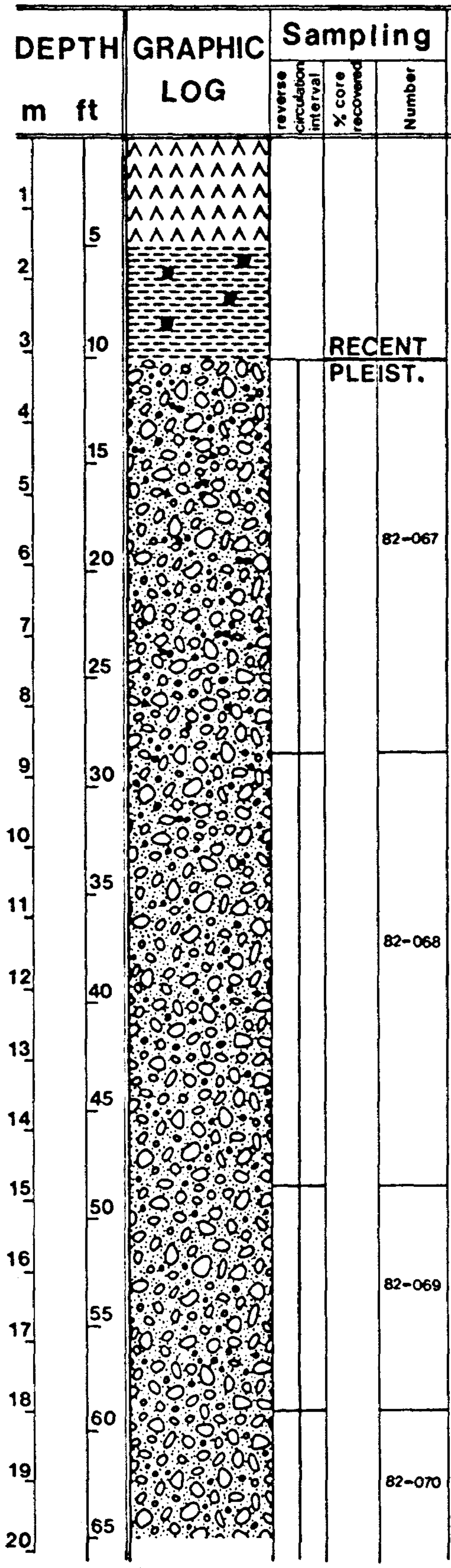
Sheet 5 of 5

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
80	260		NS		NS	
81	265			← C.S.	82-064	SANDSTONE: 265.5-267.0' Light green gritty clay with a quartz-rich sand matrix and pebble-sized subangular clasts. Clasts are a pyrite-rich sandstone; sand grains are predominantly rounded.
82				← C.S.	82-065	SOLUTION COLLAPSE BRECCIA At 267.0' clasts are dominantly limestone and siltstone with minor pyrite. From 270.0-275.0' limestone and dolomite fragments occur in very light grey soft sandy clay.
83	270				82-066	
84	275			← C.S.		LIMESTONE/DOLOMITE: 275.0-280.0' Pyritiferous carbonates.
85	280					
86						280.0': END OF HOLE
87	285					
88	290					
89						
90	295					
91	300					
92						
93	305					
94	310					
95						
96	315					
97	320					
98						
99	325					
100						

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-04 Location: Central Gentles Tp

Elev. of collar: 260 ft Sheet 1 of 7 (lat. 50°35'16" N long. 81°58'18" W)



Description

MUSKEG: 0-5.0'

MARINE CLAY: 5.0-10.0'
Soft grey-greenish clay (minor marine shells).

TILL: 10.0-97.0'
Medium light grey clay-sand till. A lot of small pebbles calcareous: clasts are both sedimentary (Paleozoic) and darker coloured basement lithologies; generally more sand than clay.

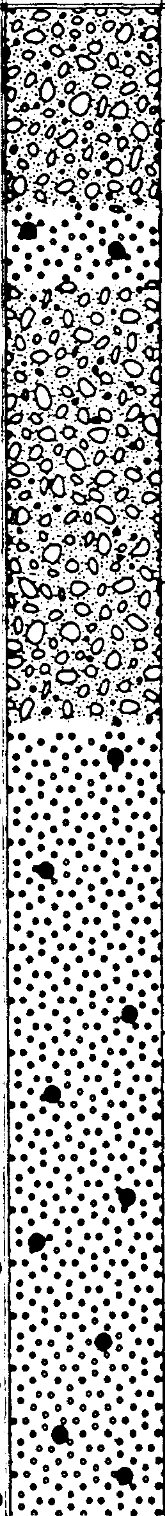
54.0': Abundant cobble-sized clasts (sedimentary and basement).

60.0': Increasingly sandy and only minor pebbles. Essentially the same as above, only different proportions.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-04

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number
	65				
20					82-070
21	70				
22					
23	75				
24	80				82-071
25					
26	85				
27	90				
28					
29	95				82-072
30	100				
31					
32	105				82-073
33	110				
34					82-074
35	115				
36	120				82-075
37					
38	125				82-076
39	130				
40					



Description

Depth	Description
75.0':	Abundant pebbles; possibly interbedded polymictic conglomerate.

CONGLOMERATE: 97.0-118.0'

Very polymictic, poorly sorted conglomerate; abundant grey chert; pebbles; occasional lignite chips.

Depth	Description
100.0-102.0':	Conglomerate becoming more of a coarse-grained sandstone.

PEBBLY SAND: 118.0-130.0'

Darker grey pebbly sand; poorly sorted, polymictic; 50/50 sedimentary/basement; very minor lignite chips.

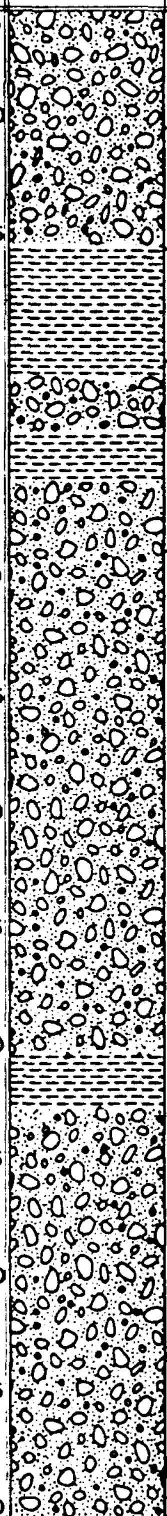
Drill Hole Nº: ONEX-82-04

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
40	130				82-077	TILL: 130.0-135.0' Dark grey-brown sandy, pebbly, clay till containing minor lignite chips.
41	135					
42					82-078	CONGLOMERATE: 135.0-139.0' Poorly sorted, sand-conglomerate containing a few cobbles and/or boulders of sedimentary (grey) rock, coarse basement clasts, and finer basement and sedimentary clasts. Trace lignite chips. By 137.0' mostly coarse sand; few cobbles.
43	140					TILL: 139.0-153.0' As above.
44	145				82-079	
45						
46	150					
47	155				82-080	CLAY TILL: 153.0-205.0' Dark grey clay till containing minor sand and gritty clay. Fewer clasts than above; calcareous clay matrix predominates (≃25%). Clasts are subangular and dominantly sedimentary (limestone/dolomite and chert). Minor basement clasts and lignite traces also occur in till. 159.0-160.0': Lignite comprises 40% of sample.
48						
49	160					
50	165					
51					82-081	
52	170					
53	175					
54						
55	180					
56						
57	185				82-082	185.0': Granite cobble. 187.0': Buff-coloured limestone/dolomite cobble. 188.0': Granite cobble.
58	190					
59						
60	195					

Drill Hole Nº: ONEX-82-04

DEPTH (m, ft): 60–80 m; 195–260 ft

GRAPHIC LOG



Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number
		82-083
		82-084
NS	←C.S.	NS
		82-085
	43	
	33	
	10	
	100	
	50	

Description

CLAY: 205.0-210.0'
Dark grey clay; calcareous and very slimy. Clay may be similar to matrix clay in previous till, but no evidence of clasts.

TILL: 210.0-213.0'
As 153.0-205.0'.

CLAY: 213.0-213.8'
As 205.0-210.0'.

TILL: 213.8-240.0'
As 153.0-205.0'.

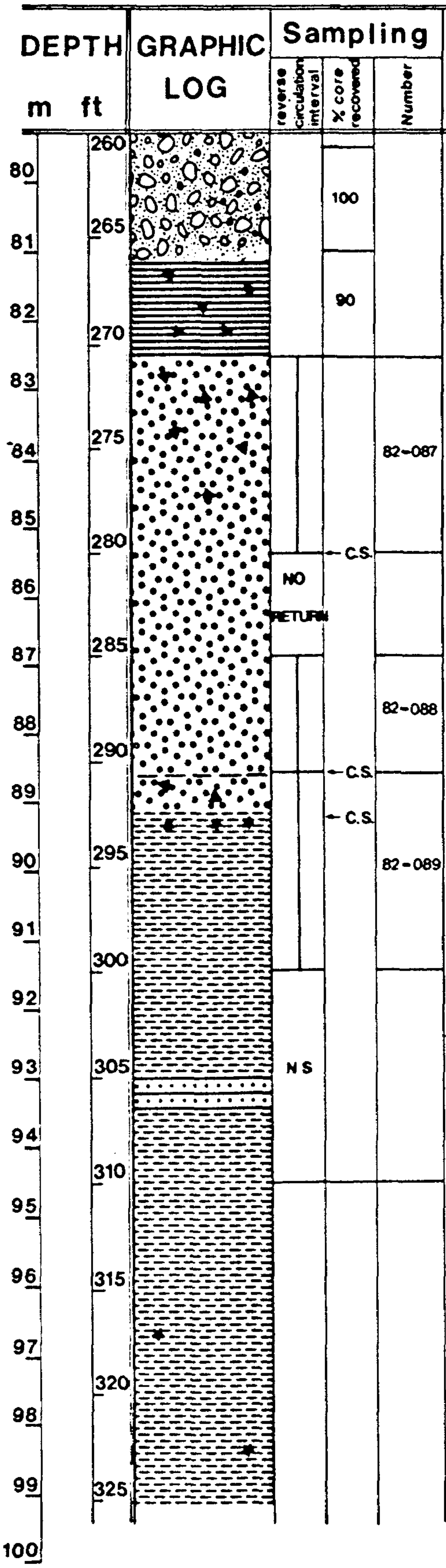
CLAY: 240.0-242.0'
Dark grey noncalcareous clay. Small interbed of light grey dolomite at 240.1-240.2'.

SANDY TILL: 242.0-266.0'
Medium grey, calcareous sandy till. Pebbles and cobbles are angular to rounded; clasts are comprised of sedimentary rocks and granite. At 253.0' till contains mostly sand-sized clasts with few pebbles.

251.0-253.0': Interlayered carbonaceous clay and medium grey sandy till; calcareous.

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-04



Description

CARBONACEOUS CLAY: 266.0-271.0'
Black carbonaceous sand and clay containing large lignitic and woody chips.

SAND AND GRAVEL: 271.0-280.0'
Coarse-grained polymictic sand and gravel. Dominantly quartz (≈80%) with minor basement, chert, limestone, and pyrite. Lignite chips constitute 15%.

280.0-285.0': No return.

SAND: 285.0-292.0'
Quartz sand and basement pebbles (95/5). Sand consists of both clear and milky quartz, and minor white mica. Quartz sand is immature. By 289.0' sand to basement ratio is 90/10; also, sand is becoming coarser.

290.5': Tan grey clay interbed.

291.0': Trace lignite.

PLEIST.
DEVON.

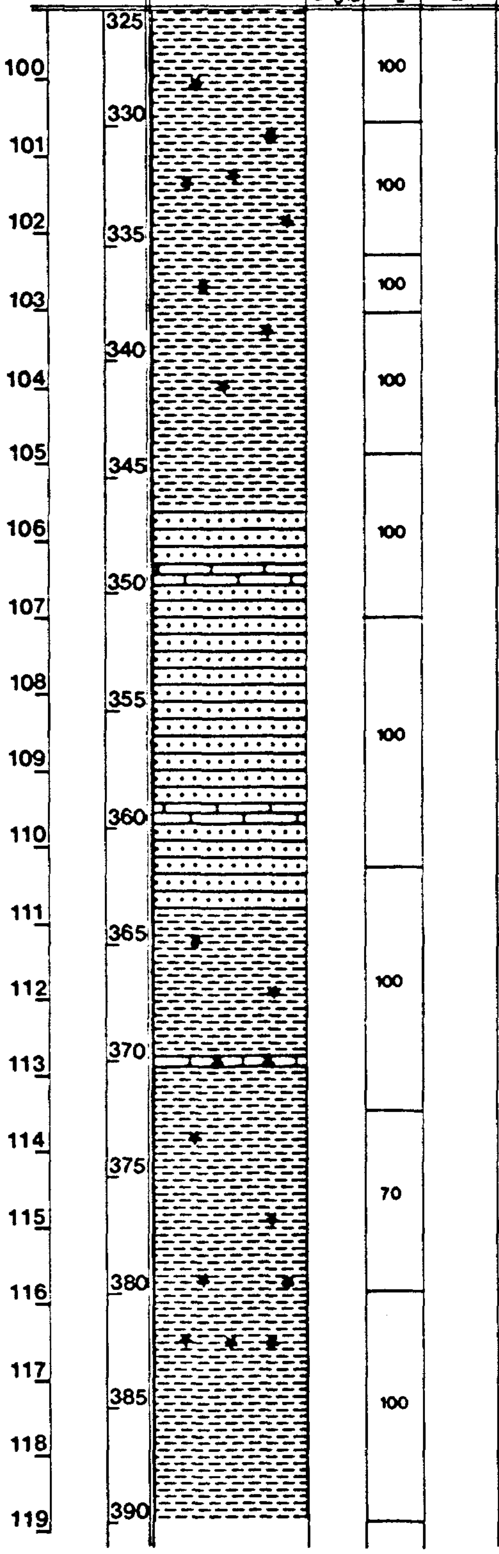
CLAY/CLAYSTONE WITH MINOR SILTSTONE LAYERS: 292.0-349.0'
Alternating layers of pale grey-green and dark chocolate brown clays/claystone; soft to stiff, non-gritty to slightly gritty, and noncalcareous. Minor pyrite occurs as blebs and disseminated crystals.

304.5-306.0': Medium grey noncalcareous siltstone.

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-04

DEPTH (m, ft)	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description



346.8-349.0': Thin limestone layers occur within a light green claystone and dark brown siltstone.

SILTSTONE AND LIMESTONE SEQUENCE: 349.0-362.0'
Thin limestone layers interbedded with dark brown pyritiferous siltstone; very calcareous. Minor light green claystone appears as thin layers and mottles.

CLAY/CLAYSTONE: 362.0-380.0'
Chocolate brown, noncalcareous claystone containing minor light green calcareous claystone interbeds. Occasional limestone layer included in sequence; ½' layer of pyritiferous limestone appears at 369.0'. Possible slump and rip-clast features evident in places. Pyrite appears as disseminated crystals and blebs throughout interval.

SHALE AND MINOR CLAYSTONE: 380.0-412.0'
Dark grey-black fissile shale containing pyrite as disseminated crystals and thin bands. Slightly calcareous with wavy calcareous laminae occurring in claystone from 392.0-400.0'.

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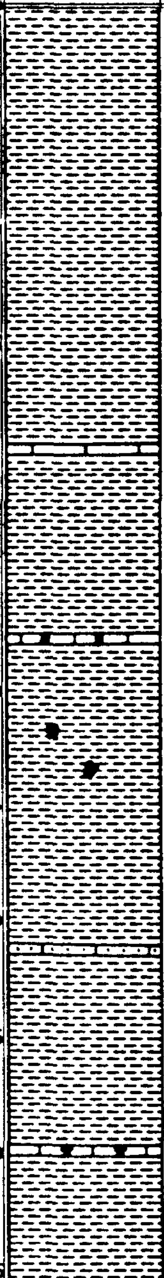
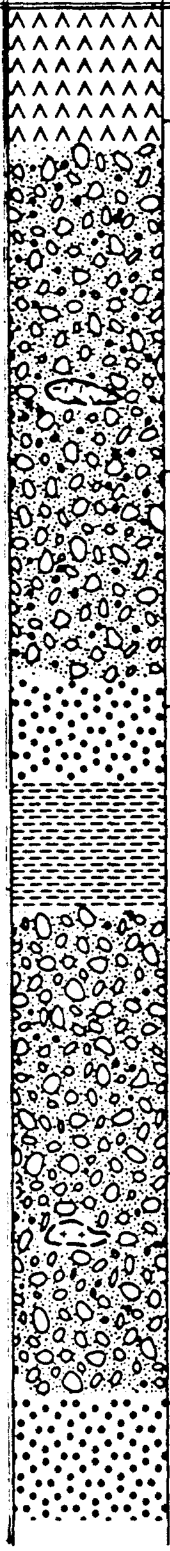
Drill Hole Nº: ONEX-82-04

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
119	390					
120						
	395			100		
121						
122	400					
23						
	405			95		
124						407.8-408.3': Light grey limestone.
125	410					
126						CLAY/CLAYSTONE: 412.0-444.0' Dominantly light grey-green calcareous claystone with minor white calcium-rich fossiliferous layers.
	415			100		
127						415.7-416.2': Grey fossiliferous limestone.
128	420					
129						
	425			100		
130						
131	430					429.6-430.0': Calcarenite(?). Quartz grains may be present; olive green in colour.
132						430.0-430.3': Extremely calcareous shale with minor pyrite along fracture surface.
	435			100		
133						
134	440					438.1-438.9': Light grey-green pyritiferous limestone.
135						
	445					444.0': END OF HOLE
136						
137						
	450					
138						
	455					
139						

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-05 Location: Central Gentles Tp

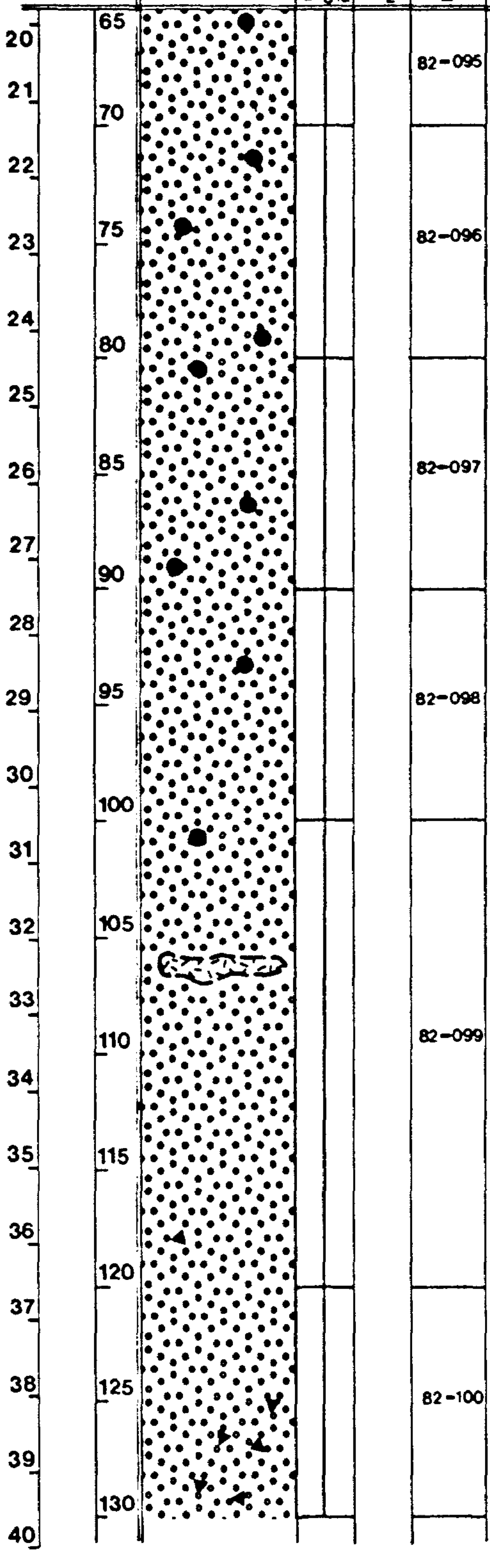
Elev. of collar: 270 ft Sheet 1 of 7 (lat. 50°34'32" N long. 81°55'39" W)

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
1						MUSKEG: 0-6.0'
2	5			RECENT / PLEIST.		SANDY PEBBLY TILL: 6.0-28.0' Grey clay matrix; very calcareous. Normal pebble suite - dominantly limestone, white and grey chert, and basement clasts.
3	10				82-090	
4–6	15–20					17.0': Granite boulder ≃5' thick.
7–8	25				82-091	
9	30					PEBBLE SAND: 28.0-33.0' Medium- to coarse-grained polymictic sand with abundant pebbles.
10–11	35				82-092	CLAY: 33.0-38.0' Light green-grey clay containing a few subangular granite fragments; clay is slightly gritty, very calcareous and soft.
12–13	40					CLAY TILL: 38.0-58.0' Sandy light green-grey, soft clay matrix. Pebbles dominantly dark basement and limestone; possibly black siltstone. Sand fraction increases from 54.0-58.0'.
14–15	45–50				82-093	
16–17	55				82-094	53.0': Basement boulder.
18–20	60–65				82-095	PEBBLE SAND: 58.0-113.0' Angular pebble-sized fragments; polymictic coarse-grained sand; pebble suite consists of 40% white chert, 20% dark basement, 15% limestone, and 10% light granite.

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-05

DEPTH (m, ft)	GRAPHIC LOG	Sampling: reverse circulation interval	% core recovered	Number	Description



84.0-113.0': Minor light green-grey, very calcareous; clay becomes a component of sand. Fragments are subangular to subrounded.

105.0-106.0': Granite boulder.

SAND: 113.0-134.0'

113.0-120.0': Lignite traces occurring in fine-grained polymictic sand. Fragments becoming smaller in size.

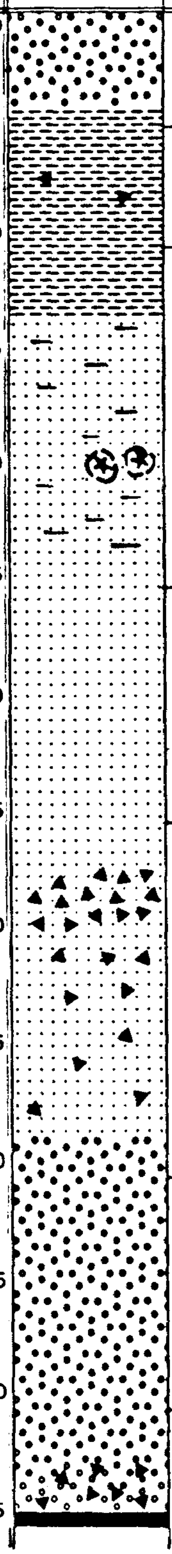
120.0-125.0': Coarse-grained polymictic sand. Absence of all fragments except lignite chips.

125.0-128.0': Large lignite and wood chips comprising ≃20% of sand.

128.0-135.0': Pebble sand as 58.0-84.0'.

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

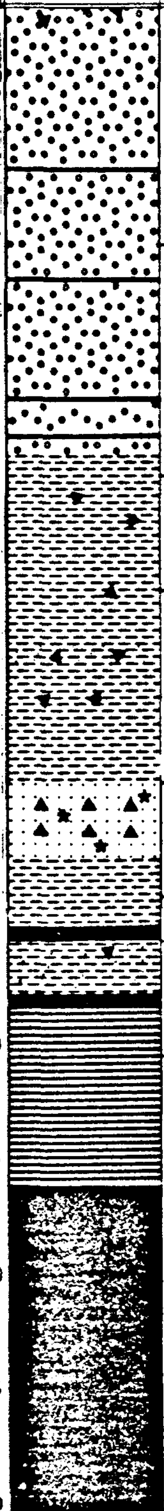
Drill Hole Nº: ONEX-82-05



DEPTH m	DEPTH ft	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
40	130				
41	135			82-100	CLAY: 134.0-135.0' Light green soft calcareous non-gritty clay.
			PLEIST. / CRETAC.		CLAY: 135.0-142.0' Light grey clay with dark mottling; medium stiff, noncalcareous, non-gritty with lignite fragments. Clay becomes more gritty at 140.0'.
42		NS		NS	
43	140				
44	145				SAND: 142.0-154.0' Very fine-grained polymictic sand; dominantly quartz and chert. Small blobs of clay are included in sample.
45				82-101	148.0-149.0': Sandstone fragments occurring along with sand as above. Some clasts are rich in disseminated pyrite and thus black in colour; sandstone fragments are tan in colour; non-calcareous.
46	150				
47	155				SILICA SAND: 154.0-179.0' White, very fine-grained silica sand (non-micaceous).
48					
49	160			82-102	
50	165				
51					167.0-169.0': Lignite chips comprise 40% of sample; possibly a seam.
52	170				169.5': Lignite comprises 15-20% of sample.
53	175			82-103	
54					177.0-179.0': Sand is becoming much coarser and slightly darker in colour.
55	180				GRAVEL/SAND: 179.0-202.0' Silica sand becoming closer to a gravel with dominant particle size ≈2 mm; 20% lignite chips.
56	185			82-104	
57					
58	190				190.0-202.0': Lignite chips comprise 30-40%.
59	195			82-105	194.0-194.5': Lignite seam in granule gravel.
60					

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-05

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number
60–80	195–260			100; 100	82-105; 82-106; 82-107; 82-108; 82-109; 82-110; 82-111

Description

LIGNITE/SILICA SAND SEQUENCE: 202.0-214.0'
The lignite/silica sand sequence consists of a 2" thick lignite seam, followed by (and not contained within) a silica sand/gravel.

CLAY: 214.0-228.0'
Medium grey, soft, slightly gritty noncalcareous clay; occasional lignite chips occurring in clay.

223.0-223.1': Minor lignite and pyrite blebs in fine sand.

225.0-228.0': Stiffer grey-brown clay containing minor mica and possible lignite seams.

SILICA SAND: 228.0-232.0'
Very fine micaceous sand with possible thin lignite seams and pyrite blebs.

CLAY: 232.0-234.0'
Grey-brown clay as above.

LIGNITE: 234.0-235.0'
Lignite grading into carbonaceous clay.

SILICA SAND: 235.0-235.5'
Sand with trace lignite.

CLAY: 235.5-237.0'
Brown sandy clay with carbonaceous clay/lignite.

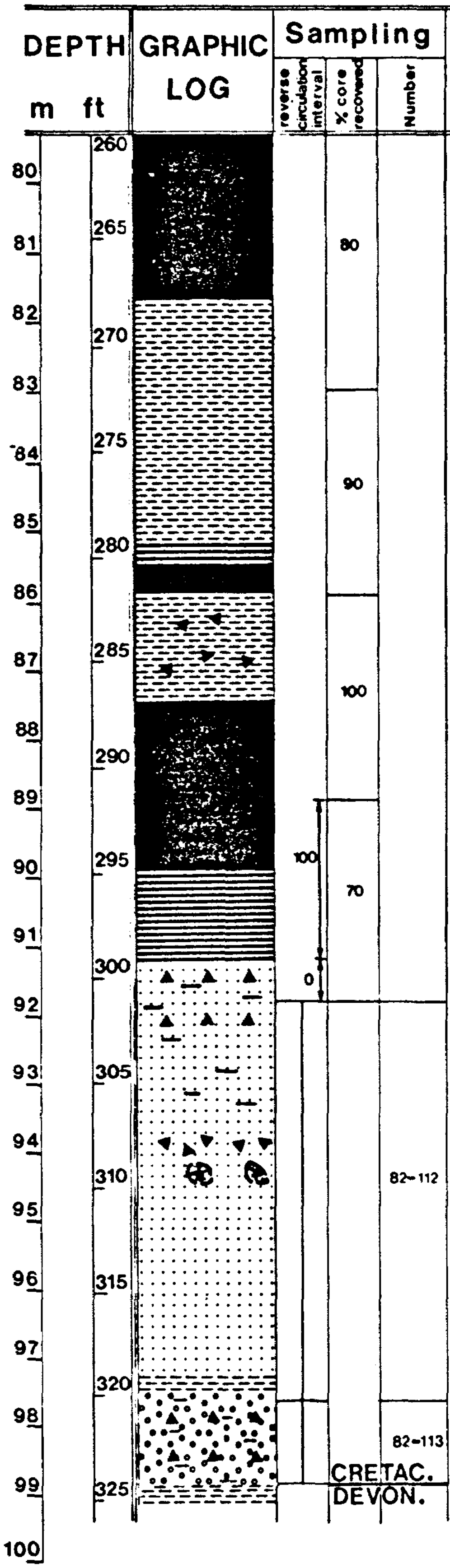
SILICA SAND: 237.0-237.5'
Sand contains trace lignite.

LIGNITE: 237.5-238.0'

CARBONACEOUS CLAY: 238.0-246.0'
Dark grey to black carbonaceous clay containing lignitic and dark brown woody chips.

LIGNITE: 246.0-268.0'
Carbonaceous clay is no longer present in lignite seam (probably vitrain). Pyrite occurs as blebs and as finely disseminated crystals in thin bands; pyritiferous seams often appear convoluted or wavy in structure.

Drill Hole Nº:ONEX-82-05



Description

CLAY: 268.0-279.5'
Medium grey/beige clay containing conspicuous flakes of muscovite; medium stiff.

LIGNITE AND CARBONACEOUS CLAY: 279.5-282.0'
Lignite (vitrain) becomes dominant component of carbonaceous clay by 280.5'.

CLAY: 282.0-287.0'
Dark grey, medium stiff clay containing lignite in layers and as chips; occasional flecks of muscovite also appear in clay.

LIGNITE: 287.0-295.0'
Lignite contains obvious blebs and/or bands of finely disseminated pyrite. Occasional flecks of muscovite appear within interval.

290.0':	Pyrite occurs as ½" layer in lignite.
291.0-292.0':	Dark brown woody sections becoming more prevalent.
294.5':	Pyrite-rich layer.

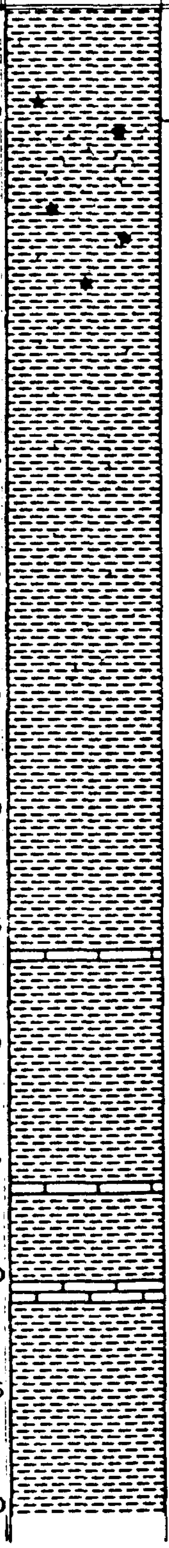
CARBONACEOUS CLAY: 295.0-299.0'
Carbonaceous clay contains large amount of lignite; medium stiff clay has woody texture.

SILICA SAND: 299.0-324.0'

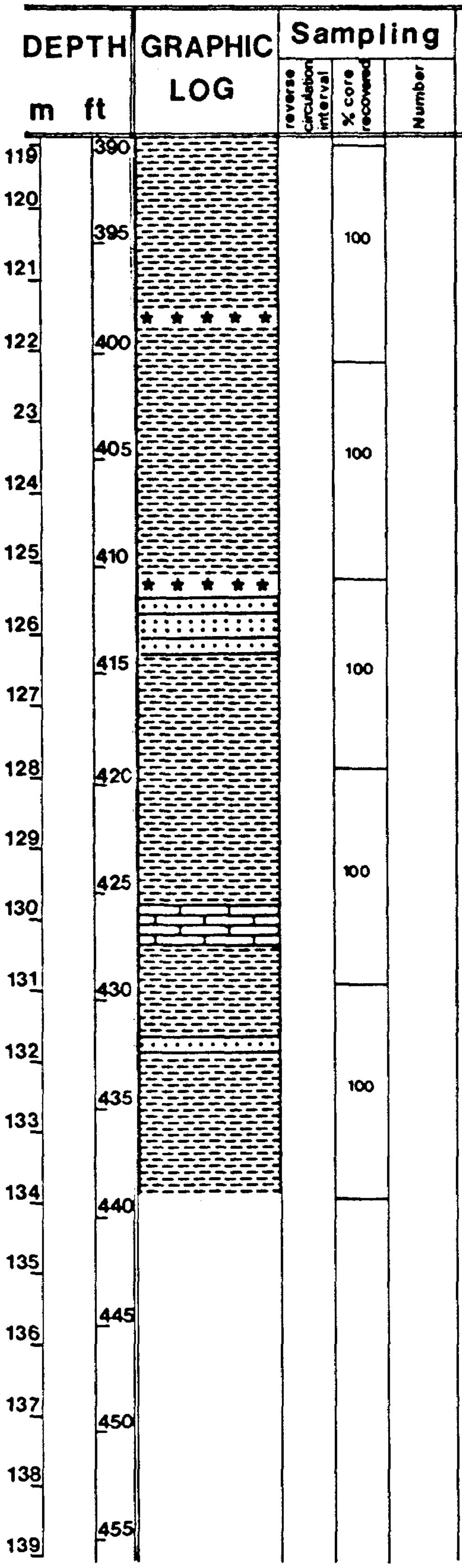
299.0-308.0':	Fine-grained quartz sand containing thin lignite layers and white kaolinitic clay.
308.0-310.0':	Wood chips, light grey clay and pyritiferous sandstone occur within silica sand as above.
310.0-319.0':	Very fine-grained, well sorted, clear quartz sand with ≈10% very fine-grained pyrite and/or lignite.
319.0-319.5':	Stiff white sandy clay and thin pyritiferous sandstone.
319.5-324.0':	Quartz sand becoming medium- to coarse-grained with thin seams or detrital lignite and thin white clay layers. Sand becomes medium-grained and clear (only 10% mafics) by 324.0'.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-05

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
	325		NS		NS	**CLAY: 324.0-365.8'** Alternating layers of pale grey-green and dark brownish-grey clays; noncalcareous, slightly gritty, and soft to stiff. Clay contains blebs and disseminated crystals of pyrite from 330.0-340.0'.
100						
	330					
101						
102	335			90		
103						
	340					
104						
105	345			100		
106						
	350					
107						
108	355			98		
109						
	360					
110						
111	365			100		**CLAY WITH MINOR LIMESTONE: 365.8-380.5'** Light grey/brown and dark brown calcareous clay with several thin limestone interbeds ranging from 1½" to 1' thick.
112						
113	370					
114						
	375			100		
115						
116	380					
117						**CLAY: 380.5-410.5'** Dominantly dark chocolate brown clay; noncalcareous, slightly gritty, and very stiff. Clay contains minor limestone layer (1½" thick) at 380.7', and a 1/8" band of pyrite at 398.7'.
	385			100		
118						
119	390					

Drill Hole Nº: ONEX-82-05



Description

SILTSTONE/CALCARENITE: 410.5-425.8'

Dark brown noncalcareous siltstone; brittle with concoidal fracture. Pyrite occurs as blebs, stringers, thin bands, and disseminated crystals. Some slightly calcareous zones may be observed in the siltstone. Minor reddish-brown calcarenite interbeds occur within interval.

CLAYSTONE/SHALE: 425.8-439.0'

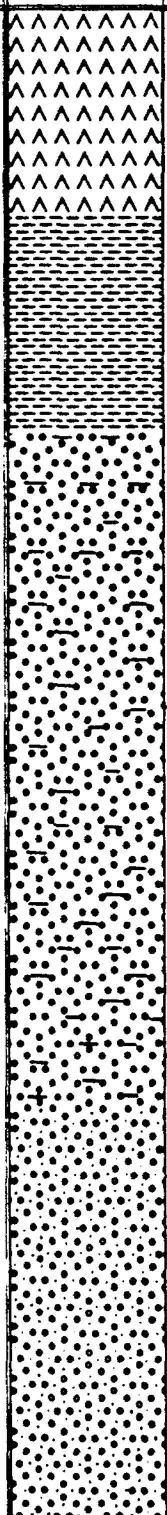
Alternating layers of grey-green and dark brown claystone; very calcareous with discrete fossiliferous interbeds. Occasional dark brown calcareous shale with minor wavy limestone layers. Siltstone as above at 431.5-432.0'.

439.0': END OF HOLE

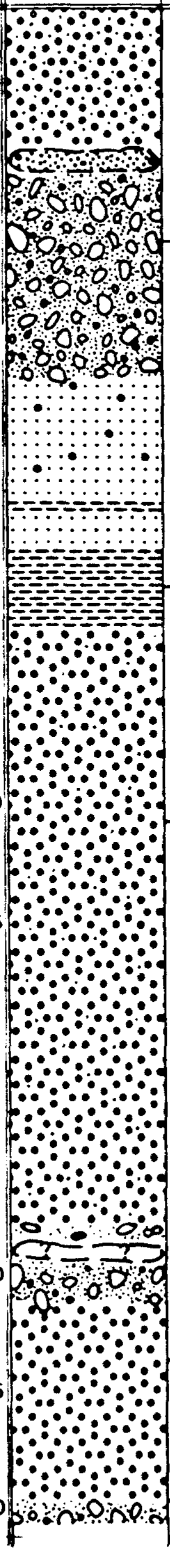
1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-06   Location: West Central Pickett Tp

Elev. of collar: 230 ft ± 20 ft   (lat. 50°35'47" N long. 81°52'26" W)

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
0–3	0–9					MUSKEG: 0-9.0'
3	10					CLAY: 9.0-11.0' Light green-grey; calcareous.
4–5	11–18				82-114	CLAY: 11.0-18.0' Light green-grey; contains pebbles and cobbles; 60% limestone, 40% basement (predominantly granite).
6–14	18–47			RECENT / PLEIST.	82-115	CLAY TILL: 18.0-47.0' Green-grey, calcareous. Pebbles include 60% buff-coloured limestone, 30-40% basement, 5-10% miscellaneous (including red jasper pebbles).
14–20	47–65			C.S.	82-116	SAND AND GRAVEL: 47.0-71.0' Fine to medium sand. Gravel is 70% basement (granite, black siltstone or basalt), 25% light-coloured limestone, 5% other.
17	55–58					55.0-58.0': Increased amount of fine sand.

Drill Hole Nº: ONEX-82-06

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	% core recovered	Number
20–40	65–130				82-117, 82-118, 82-119, 82-120, 82-121

Description

68.0-69.0': Red jasper boulder.

CLAY TILL: 71.0-81.0'
Sedimentary boulder at 71.5-72.0'.

FINE SAND AND GRAVEL: 81.0-86.0'
With minor clay; gravel is 65% sedimentary pebbles and 35% basement.

TRANSITION: 86.0-88.0'
Interlayered sand and clay.

CLAY: 88.0-92.0'
Medium grey, calcareous.

SAND AND GRAVEL: 92.0-96.0'
Sandy with pebbles and cobbles; 75% limestone and 25% basement.

SAND AND GRAVEL: 96.0-117.0'
Minor sand with pebbles and cobbles; 50/50 sedimentary/basement.

102.0': Boulder(?).

105.0-105.5': Sand layer.

108.0-109.0': Minor wood fragments; increased sand content.

111.0-112.0': Sand layer.

TILL: 117.0-121.0'
Clayey with pebbles and cobboes.
118.0-119.0': Pink granite boulder.

SAND AND GRAVEL: 121.0-123.0'
Sandy with pebbles and cobbles; 80% basement (predominantly granite), 20% sedimentary (limestone).

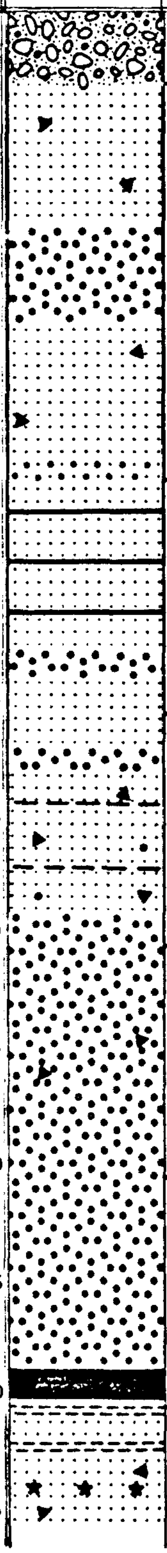
SAND, PEBBLES, COBBLES: 123.0-129.0'
Material to cobble size. Contains shell fragments and minor detrital(?) lignite.
128.0-129.0': ≈15% lignite fragments (thin seam?).

SANDY TILL: 129.0-133.0'
Medium grey-brown sandy clay; calcareous; few pebbles; minor lignite. Minor wood fragments at 131.5-133.0'. Pebble sedimentary/basement ratio 3/1.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-06

DEPTH (m: 40–60; ft: 130–195) | GRAPHIC LOG | Sampling (reverse circulation interval; % core recovered; Number) | Description



Sample numbers: 82-122, 82-123, 82-124, 82-125, 82-126, 82-127

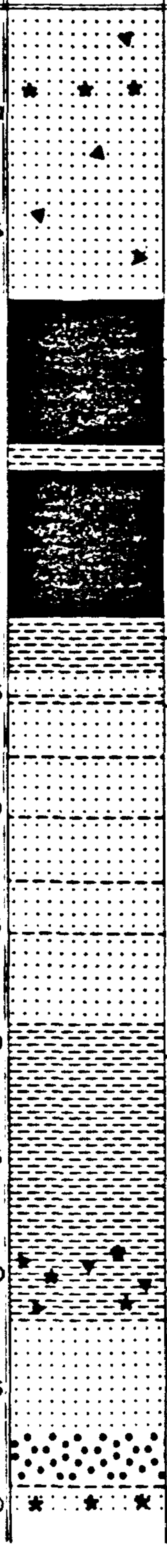
PLEIST. / CRETAC.

SANDS: 133.0-207.0'

Interval	Description
133.0-139.0':	Fine-grained quartz sands; 20% sedimentary fragments, 10% basement fragments, minor lignite.
139.0':	Thin lignite seam? Large (to 1") pieces of black lignite.
139.0-141.0':	Medium-grained sand.
141.0-143.0':	Gravel; mostly sedimentary pebbles.
143.0-149.0':	Fine sand; at 143.0' 1-2" lignite seam(?).
149.0-150.0':	Gravel.
150.0-157.0':	Fine sand; possible thin lignite seams (several).
157.0-158.0':	Coarse quartz sand and rock fragments (cobble?).
158.0-161.0':	Fine sand.
161.0-162.0':	Sand and gravel.
162.0-168.0':	Fine sand, occasional pebbles; minor lignite; several thin light grey gritty clay seams.
168.0-173.0':	Medium-coarse grained quartz sands.
173.0-176.0':	Fine-medium sand; contains sedimentary and basement fragments. Minor lignite (detrital) at 174.0'.
176.0-178.0':	Coarse quartz sand; quartz 80%, sedimentary clasts 15%, basement clasts 5%.
178.0-181.0':	Gravel; predominantly quartz pebbles.
181.0-188.0':	Predominantly medium sand; 10-15% sedimentary and basement pebbles and clasts.
188.0-189.5':	Lignite.
189.5-190.0':	Pyritic or micaceous clay.
190.0-190.5':	Fine sand (contamination?).
190.5-191.0':	Carbonaceous clay; noncalcareous.
191.0-207.0':	Fine sand; minor lignite; several 1-2" pyrite layers.

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº :ONEX-82-06

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
60–80	195–260					

Depth scale: m 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80; ft 195, 200, 205, 210, 215, 220, 225, 230, 235, 240, 245, 250, 255, 260

Sampling: 82-128 (← C.S.); 82-129; NS / NS; 82-130 (← C.S.); 82-131; 82-132

Description

LIGNITE AND CLAY: 207.0-222.0'

207.0-214.0':	Lignite; black.
214.0-214.5':	Clay; dark grey.
214.5-218.0':	Lignite; black.
218.0-221.0':	Lignite; mostly brown, some black.
221.0-222.0':	Carbonaceous clay; minor pyrite.

CLAY, SAND, AND GRAVEL: 222.0-241.0'

222.0-223.5':	Tan - medium grey clay and thin pyrite layers at top of interval. Unit is slightly micaceous; noncalcareous.
223.5-224.0':	Medium brown-grey clay.
224.0-224.5':	Fine sand.
224.5-225.0':	Clay with minor lignite.
225.0-238.0':	Medium to coarse quartz sand with minor lignite. Occasional buff coloured clay layer.
238.0-241.0':	Buff coloured clay with minor lignite.

CLAY: 241.0-251.5'

Light brown, gritty clay; micaceous.

246.0':	Detrital lignite.
248.0-251.0':	Abundant detrital brown lignite and chunks of pyrite.
251.0-251.5':	Clay becomes dark brown, still gritty with detrital lignite.

FINE SAND: 251.5-256.0'

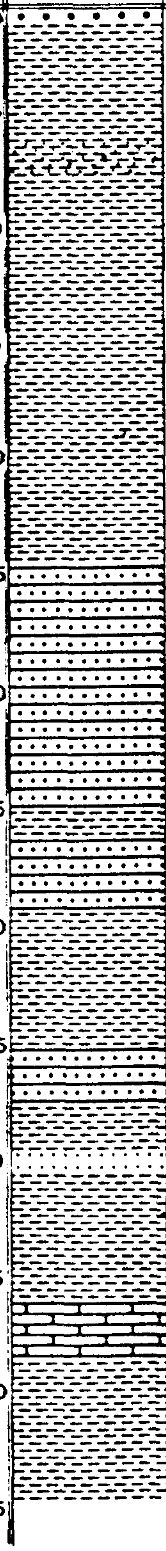
COARSE SAND AND GRAVEL: 256.0-258.0'

INTERLAYERED CLAY AND SAND: 258.0-261.5'

Interval includes brown, sandy clay, chunks of pyrite, fine to coarse quartz sands.

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº :ONEX-82-06

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number
80–99	260–325		NS (260–286 ft); NS (320–327 ft)	CRETAC. / DEVON.	NS (260–286 ft); 82-133 (286–301 ft); 82-134 (301–320 ft); NS (320–327 ft)

Depth scale: m 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100; ft 260, 265, 270, 275, 280, 285, 290, 295, 300, 305, 310, 315, 320, 325

Description

CLAY: 261.5-283.0'

- 261.5-264.0': Medium blue-grey clay; noncalcareous.
- 264.0-265.0': Medium grey clay; noncalcareous.
- 265.0-268.0': Grey-green clay with coarse quartz sand (from above); noncalcareous.
- 265.0': ½" of light green grey brittle mineral; slightly calcareous.
- 267.0': No longer quartz sand.
- 268.0-271.0': Tan - light brown, soft slimy clay.
- 271.0-273.0': Dark brown-grey clay, stiff, noncalcareous.
- 273.0-281.0': Tan-buff calcareous material, probably marl; soft and brittle, becoming more brown-grey with depth.
- 281.0-283.0': Medium grey calcareous clay, moderate stiffness.

SAND, SILTSTONE, AND CLAY: 283.0-308.5'

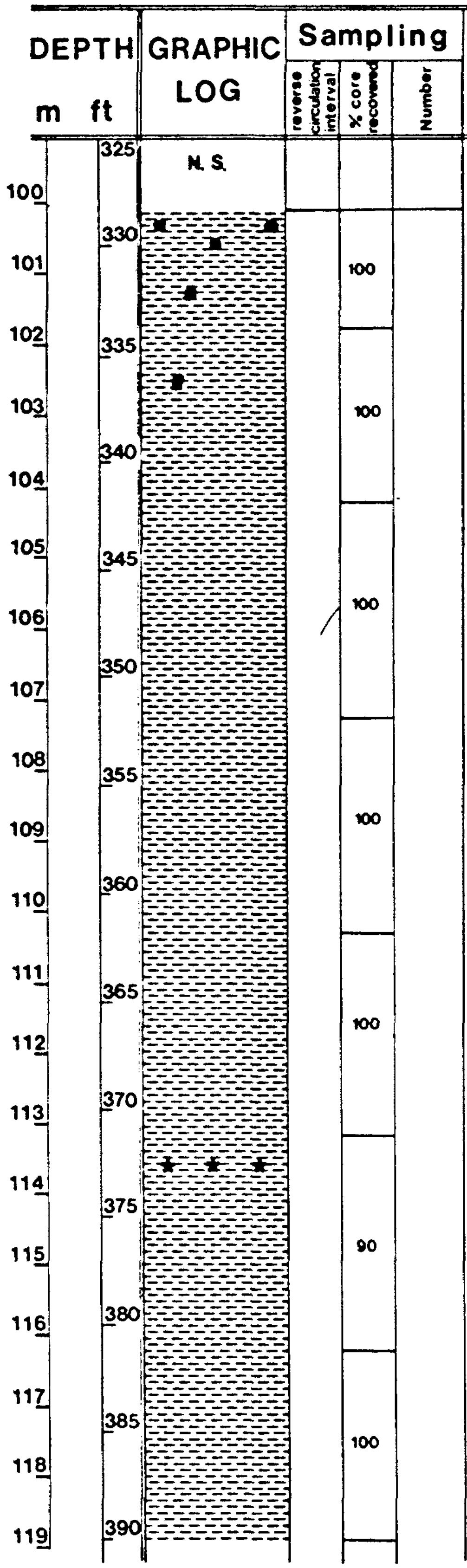
- 283.0-294.0': Fine sand and light cream to brown coloured siltstone.
- 294.0-294.5': Light grey-green calcareous clay; soft to moderately stiff.
- 294.5-298.0': Same as 283.0-294.0'.
- 298.0-304.0': Soft, light green-grey to buff clay.
- 304.0-306.0': Brown to grey calcareous siltstone.
- 306.0-308.0': Medium-dark grey calcareous clay; gritty.
- 308.0-308.5': Fine sand.

CLAY: 308.5-324.0'

- 308.5-315.0': Soft grey calcareous clay.
- 315.0-317.0': Brown limestone and white-buff limestone and sand.
- 317.0-318.0': Medium grey calcareous clays.
- 318.0-319.0': Medium-grained quartz sand (from above?).
- 319.0-320.0': Greenish grey clay; only slightly calcareous; stiff.
- 320.0-323.0': Greenish-grey clay; strongly calcareous, stiff.
- 323.0-324.0': Light grey calcareous clay; stiff.
- 324.0-327.0: LOST SAMPLE.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-06



Description

CLAYSTONE/MUDSTONE: 327.0-441.0'

327.0-331.4': Grey-brown, calcareous mudstone with abundant white calcite blebs; possible fossils.

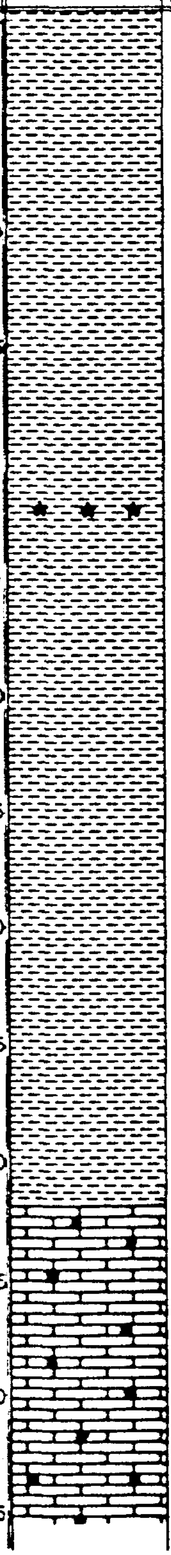
331.4-392.0': Grey-brown to slightly green-grey calcareous mudstone; occasional calcite bleb/fossil to 340.0'; minor thin dark banding present. May also be considered a slightly gritty clay. This unit is very stiff and dry, breaks with conchoidal type fracture, conical in shape.

371.9': Trace pyrite.

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-06

Sheet 7 of 8

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: % core recovered	Description
119–139	390–455		100, 100, 100, 100, 100, 75, 75, 90	see below

Depth scale (m): 119, 120, 121, 122, 23, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139

Depth scale (ft): 390, 395, 400, 405, 410, 415, 420, 425, 430, 435, 440, 445, 450, 455

Sampling columns: reverse circulation interval; % core recovered; Number

Description

CLAYSTONE: 392.0-402.0'
Light green-grey, very calcareous; non-gritty. Contains occasional calcite-rich sections ≈1" thick composed of wavy laminae of white calcite.

CLAYSTONE: 402.0-412.0'
Medium grey; very calcareous; slightly gritty. Some sections are much harder than others. Possibly limestone, but cannot determine since no crystalline texture is evident. May contain thin layers of very finely disseminated pyrite (e.g., 411.5').

CLAYSTONE: 412.0-422.0'
Similar to 402.0-412.0' except pyrite is not evident. Unit tends to be very dry.

CLAYSTONE: 422.0-436.5'
Similar to 412.0-422.0' except slightly softer with fewer well indurated calcite-rich sections.

CLAYSTONE: 436.5-438.5'
Becoming darker in colour, less soft, still calcareous.

CLAYSTONE/MUDSTONE: 438.5-441.0'
Medium brown, calcareous, slightly gritty, very dry and harder than above claystone. Contains pyrite as disseminated crystals and occcasional blebs.

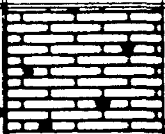
FOSSILIFEROUS LIMESTONE: 441.0-442.0'
Medium brown, very fossiliferous; biomicrite (dominantly mud matrix).

FOSSILIFEROUS LIMESTONE: 442.0-449.0'
Light green-beige, spar > micrite, therefore probably a biosparite. Appears as though dissolution and possibly some brecciation has taken place with sulphide minerals occurring as replacement pyrite and possible galena/sphalerite. Sulphide minerals also occur as replacement in fossil fragments and druse in cavities.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº :ONEX-82-06

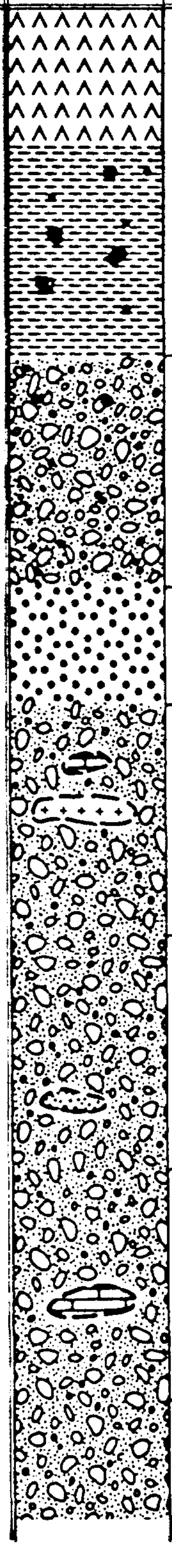
Sheet 8 of 8

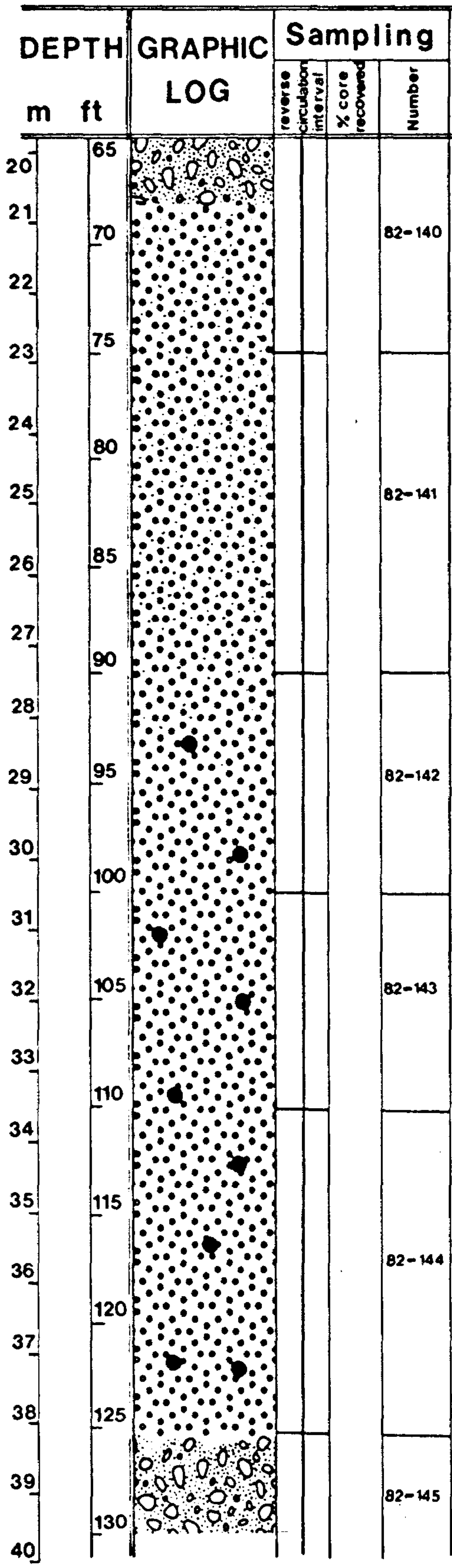
DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
139	455			90		FOSSILIFEROUS LIMESTONE: 449.0-452.0' Same as 442.0-449.0'. Less sulphide mineralization. At ≈251.5' large coral fossil.
140	460			100		FOSSILIFEROUS LIMESTONE: 452.0-460.0' Dominantly light beige fossiliferous sparite (lesser percent of allochems then above); fewer cavities; no obvious sulphide replacement minerals. Possibly a biomicrite occurring at 253.5' (dark very fossiliferous) and 254.5'. Difficult to determine in-hand specimen, probably still solution collapse breccia. Minor light grey fossiliferous sparite after 458.0'. 460.0': END OF HOLE

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-07   Location: Central Gentles Twp

Elev. of collar: 256 ft   Sheet 1 of 7   (lat. 50°33'32" N long. 82°01'37"W)

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
0–2	0–6.0					MUSKEG: 0-6.0'
2–4.5	6.0–15.0		NS		NS	MARINE CLAY: 6.0-15.0' Light green-grey soft clay; very calcareous containing shells-bivalves (well preserved); some pebbles, dominantly basement.
	15			RECENT / PLEIST.		
4.5–7.6	15.0–25.0				82-135	PEBBLE TILL: 15.0-25.0' Light green-grey soft pebble till; very sandy; clasts consist of limestone, basement, some dark brown wood chips. 17.0': Sedimentary boulder.
7.6–9	25.0–30.0				82-136	PEBBLE SAND: 25.0-30.0' Polymictic, very calcareous; matrix dominantly medium-grained; some clay particles in sand matrix.
9–12	30.0–40.0				82-137	CLAY PEBBLE TILL: 30.0-48.0' Light green-grey clay pebble till; very calcareous; sandy. 31.0': Cobble-limestone/dolomite only ≈2" thick. 32.5-34.0': Boulder-quartzite(?) white crystalline, non-calcareous.
12–15.5	40.0–51.0				82-138	47.0': Boulder-sedimentary (limestone/chert, minor granite). SANDY TILL: 48.0-52.0' Dominantly medium grey polymictic sand, medium-grained, submature; medium grey-green minor clay component.
15.5–18.5	51.0–59.0				82-139	CLAY TILL: 52.0-57.0' Medium green-grey gritty clay; very calcareous minor sand; dominantly limestone; chert, dark basement, quartzite, and granite occurring as minor clasts. 55.0': Boulder - limestone.
18.5–20	59.0–66.0				82-140	SANDY TILL: 57.0-68.0' As above; dominantly pebble-sized clasts. Limestone, chert and basement in composition, some shell fragments at 67.0'.



Description

PEBBLE SAND: 68.0-90.0'

Dominantly medium grey polymictic sand, fine-grained with abundant pebbles; clasts comprised of limestone, chert, and basement rock.

82.0-90.0': Sandy component becoming much coarser than above — medium to coarse-grained sand.

GRAVEL: 90.0-125.0'

Polymictic gravel; decrease in sandy component from above — pebble-sized fragments prevail; pebbles composed of limestone, chert, granite, jasper, feldspar, light inosilicates, and dark basement; subrounded pebbles ranging in size from coarse-grained sand to ≈5 mm pebble; calcareous matrix.

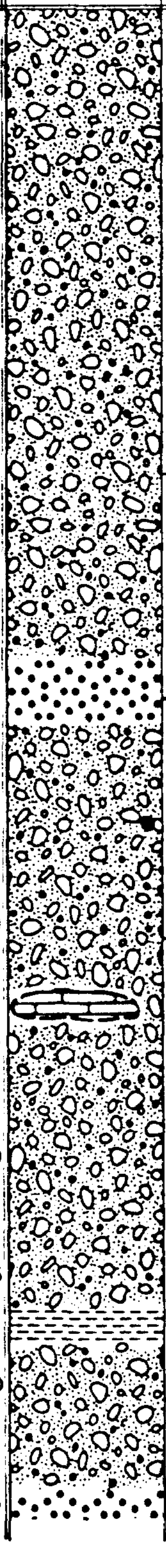
CLAY TILL: 125.0-158.5'

Medium green-grey clay till, very gritty, medium stiff, very calcareous.

126.0-140.0': Clay becomes more predominant than above with sand and granule-sized clasts as minor components; contains buff-coloured limestone clasts and less than 10% sand; possibly a clay as opposed to a till.

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-07

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
40–60	130–195				82-146, 82-147, 82-148, 82-149	see below

Depth scale (m): 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60

Depth scale (ft): 130, 135, 140, 145, 150, 155, 160, 165, 170, 175, 180, 185, 190, 195

Sample numbers: 82-146, 82-147, 82-148, 82-149

Description

140.0-151.0': Green-grey clacareous clay till; sedimentary and basement pebbles occur 2 : 1, rounded to subangular; clay stiff.

151.0-153.0': Slightly more gritty, but still generally same as 140.0-151.0'.

153.0-158.5': Same as 140.0-151.0'.

GRAVEL: 158.5-160.0'

Gravel — rounded to subrounded; black siltstone/basement 30–40%; granite 5–10%; buff limestone 50–60%.

PEBBLE CLAY TILL: 160.0-193.0'

Pebble clay till; minor sedimentary fraction; brownish-grey clay, calcareous; sedimentary/basement ≃2 : 1; pebbles mostly subrounded to angular.

166.0-168.0': Increased sand content.

173.0': Boulder ½' limestone.

179.0': Slightly lighter coloured.

185.5-187.0': Medium grey-green calcareous clay; very stiff; minor quantity of subrounded to subangular limestone.

187.0-193.0': Same as interval from 179.0-185.5'; sedimentary basement ≃4 : 1.

SAND AND CLAY SEQUENCE: 193.0-201.0'

193.0-197.0': Fine sand, minor lignite.

196.0-196.3': Lignite.

196.0': Pebbles rounded.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-07

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number
60–80	195–260			PLEIST. / CRETAC.; 100	82-149; 82-150; 82-151; 82-152; NS; 82-153

Description

CLAY: 197.0-201.0'
Light green noncalcareous stiff clay with thin sand layers (possibly cave) at 198.0-199.5'.

SANDY TILL: 201.0-214.5'
Light brown-grey coarse-grained polymictic sand with a medium grey to light green clay matrix; sand is calcareous. Till contains from 10–15% lignite chips.
205.0-206.0': Minor light green-grey clay interbed with trace lignite.

CLAY: 214.5-218.0'
Medium green-grey clay with ≈10% lignite and very minor sandy component; noncalcareous.

SANDY TILL: 218.0-220.0'
As above.

SAND: 220.0-256.5'
Light grey, medium- to coarse-grained polymictic sand containing 20–40% lignite chips. Sand is very calcareous with several clay interbeds, especially from 234.0-244.0'.
222.0-222.5': Clay till(?) with clasts of limestone, quartz, and dark basement.
226.0-234.0': No return.

237.8-238.5': Light green-grey clay with very minor fine grit.
246.0-247.0': Pyrite pseudomorphing of lignite chips within coarse-grained sand.
247.0-248.0': Medium grey, pyritiferous, noncalcareous clay.
249.0-254.0': Light green and grey alternating clays with minor mottling. Very gritty/sandy and pyritiferous in places. Lignite chips (≈40%) occur in minor sand seam at 252.0-263.0'.

LIGNITE: 256.5-256.7'
Thin lignite seam contains minor chert and pyrite.

SAND: 256.7-259.0'
As above with white pyritiferous chert.

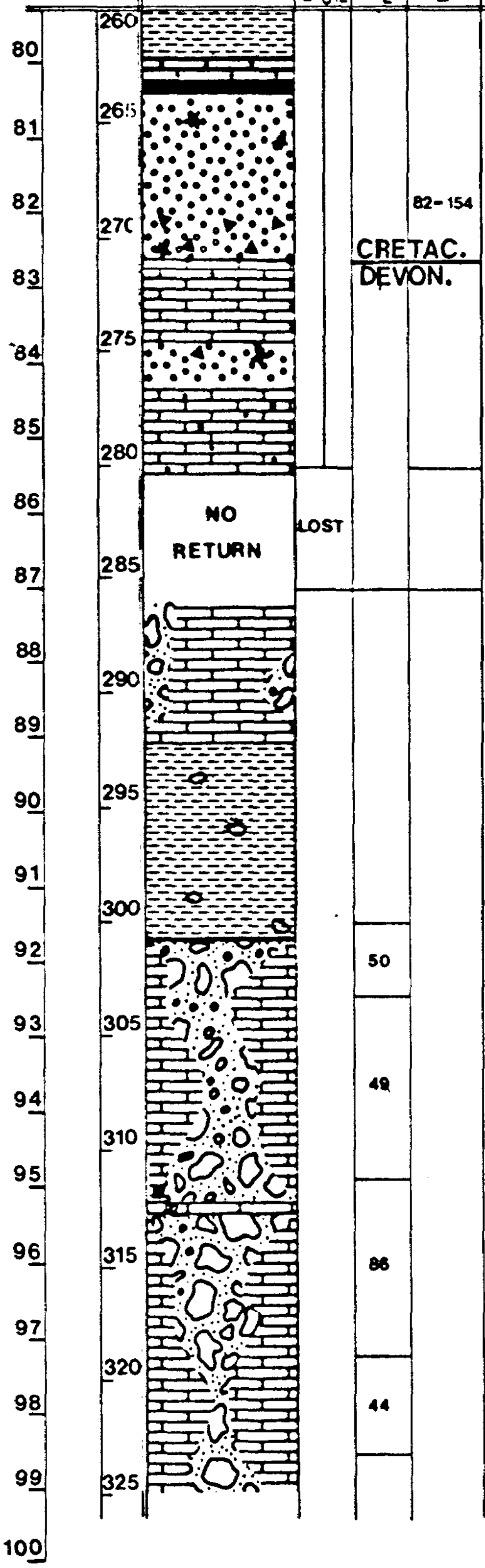
LIGNITE: 259.0-259.1'

CLAY: 259.1-261.0'
Medium blue-grey clay, slightly gritty clay with trace lignite becoming white by 260.5'.

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-07

DEPTH (m, ft)	GRAPHIC LOG	Sampling (reverse circulation interval, % core recovered, Number)	Description



SAND AND MINOR LIGNITE: 261.0-262.6'
As above.
LIGNITE: 262.0-263.2'
SAND: 263.2-271.2'
As above, grading into light green, slightly gritty clay.
268.0-270.0': Lignite chips comprise ≈40%.

LIMESTONE: 271.2-274.0'
Buff, tan and grey angular limestone fragments; some laminae evident.
SAND: 274.0-276.0'
As 263.2-271.0'.
LIMESTONE: 276.0-280.0'
Sand still issuing along with limestone
280.0-286.0': NO RETURN

LIMESTONE BRECCIA: 286.0-292.0'
Limestone cobbles and boulders in sandy clay. Clay is medium grey-green. Polymictic sand and pebbles, although predominantly limestone.
290.0-292.0': Most clay and sand washed away.
CLAY: 292.0-300.0'
Tan silty clay with numerous light green calcareous blebs.

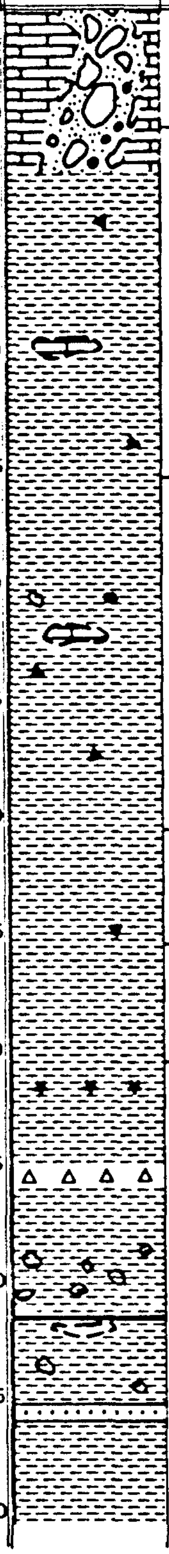
LIMESTONE BRECCIA: 299.5-331.0'
Same as 286.0-292.0'.

311.2-311.4': Lignite/clay/pyrite layer.
311.5-312.0': Green-grey fossiliferous limestone.

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-07

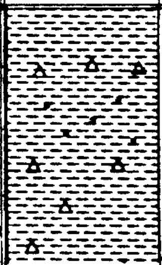
Sheet 6 of 7



DEPTH m	DEPTH ft	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
100	325, 330		44		
101, 102, 103, 104, 105	335, 340, 345			155	CLAY WITH MINOR ANGULAR LIMESTONE CLASTS: 331.0-401.0' Light green very calcareous gritty clay containing angular buff to light brown limestone fragments and lignite chips (15%); fine- to medium-grained buff-coloured polymictic calcareous sand in return (submature).
106, 107, 108, 109	350, 355, 360			156	351.0-351.3': Buff limestone subangular fragments ≃3" thick, probably a cobble.
110, 111	365			157	
112	370	NS		NS	365.0-365.5': Tan coloured siltstone, very calcareous is occurring in clay.
113, 114, 115, 116, 117, 118, 119	375, 380, 385, 390			158	374.5-375.0': Buff-coloured, subangular limestone fragments; still trace lignite; however, clay is absent. 380.5-380.7': Dominantly lignite chips (≃80%) occurring in grey gritty clay. 384.2-385.0': Appearance of tan/salmon coloured siltstone fragments in a medium grey slightly calcareous clay.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-07

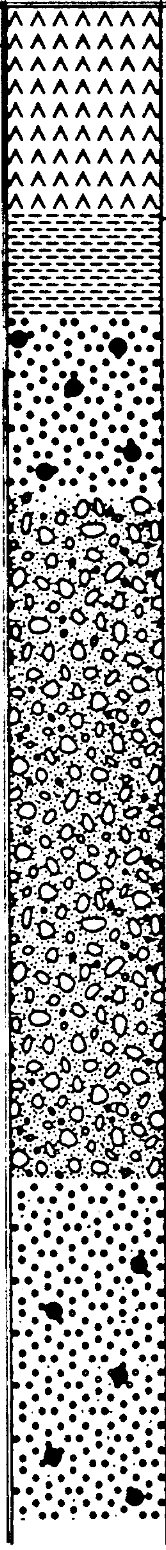
DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
119	390					
120	395		NS		NS	
121						396.0-396.5': Light red clay with green-grey mottling; very calcareous.
122	400					
23						401.0': END OF HOLE
	405					
124						
125	410					
126						
	415					
127						
128	420					
129						
	425					
130						
131	430					
132						
	435					
133						
134	440					
135						
	445					
136						
137	450					
138						
	455					
139						

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-08 Location: WEST OF GENTLES TWP.

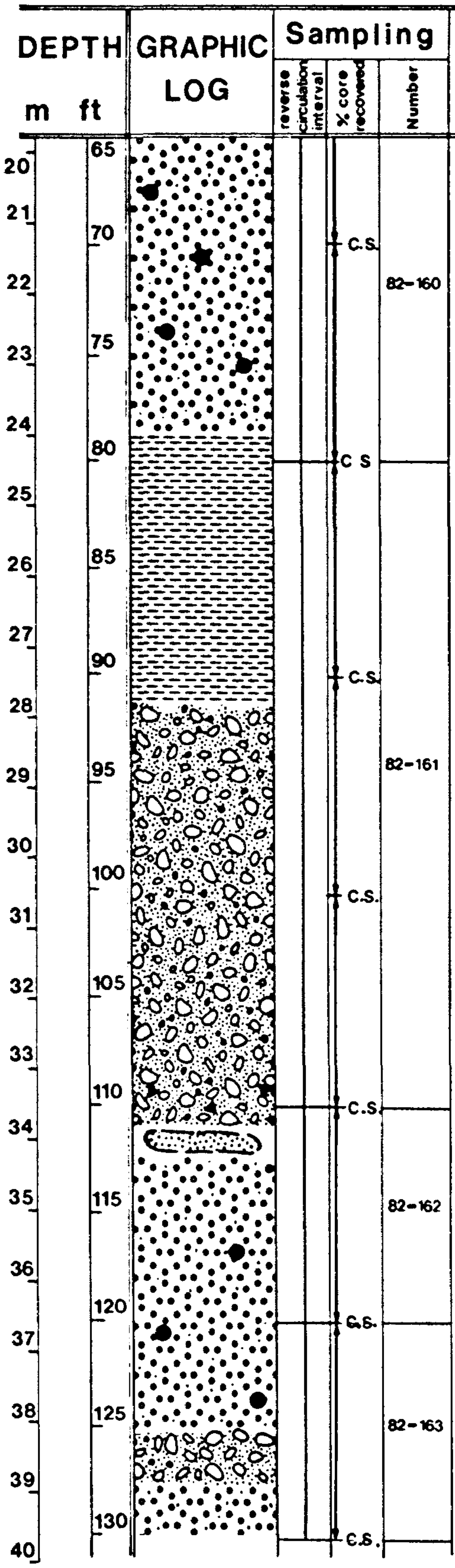
Elev. of collar: 271 ft Sheet 1 of 7 (lat. 50°32'01" N long. 82°07'31" W)

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
1, 2	5		NS		NS	MUSKEG: 0-9.0'
3, 4	10			RECENT		CLAY: 9.0-13.0' Green, noncalcareous, non-gritty clay.
5, 6	15, 20			PLEIST.		SAND: 13.0-20.0' Fine-grained particles to pebbles, polymictic; very little retrieved.
7–15	25, 30, 35, 40, 45, 50		NS	C.S.	NS	PEBBLE TILL: 20.0-50.0' Light green-grey clay, polymictic pebbles, dominantly clay matrix.
16–20	55, 60, 65			C.S.	82-160	PEBBLE/COBBLE SAND: 50.0-78.0' Polymictic pebbles and cobbles in fine sand; chert and basement clasts.



1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole No: ONEX-82-08



Description

CLAY: 78.0-90.0'
Light green-grey, noncalcareous clay.

CLAY TILL: 90.0-111.0'
Light green-grey clay, polymictic pebbles, minor clay; dominantly pebbles.

107.0-111.0': Lignite traces.

111.0': Sedimentary boulder.

GRAVEL: 111.0-124.0'
Very sandy, pebble gravel; polymictic; quartz, chert, basement and other.
112.0': Traces of lignite.
117.0': Sedimentary boulder.
124.0': Trace lignite.

TILL: 124.0-126.0'
Light grey, basement and sedimentary pebbles; minor grit.

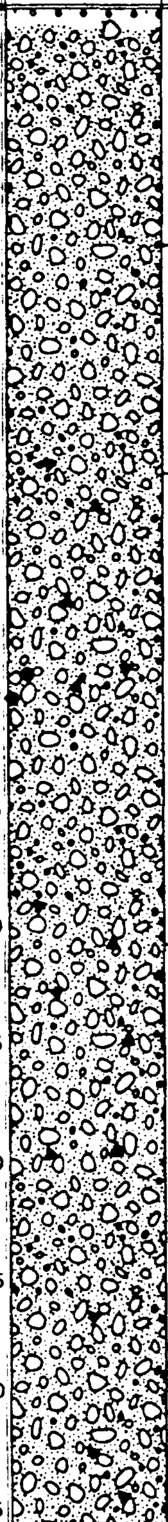
GRAVEL: 126.0-128.0'
Sandy pebbly gravel; polymictic.

TILL: 128.0-237.0'
Light grey-green clay matrix, strongly calcareous. Polymictic pebbles dominantly of sedimentary origin (some limestone); minor grit.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-08

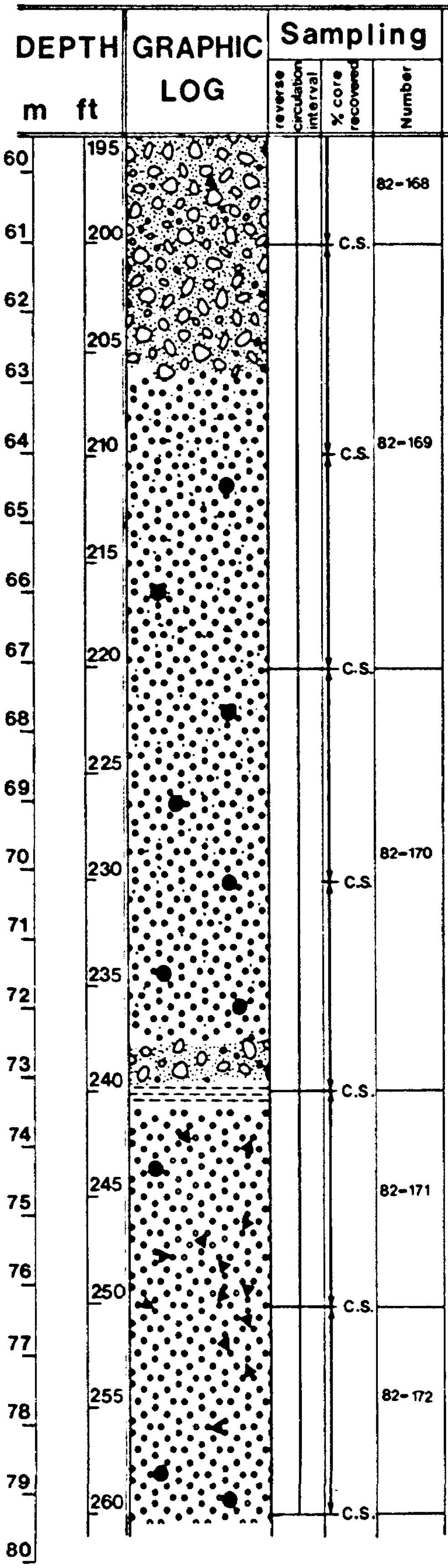
GRAPHIC LOG



DEPTH m	DEPTH ft	Sampling: % core recovered	Sampling: Number	Description
40	130			
41	135		82-164	
42				
43	140	C.S.		
44	145		82-165	
45				147.0': Trace lignite. 149.0': Trace lignite.
46	150	C.S.		151.0': Trace lignite.
47	155			155.0-156.0': Trace lignite.
48			82-166	158.0': Trace lignite.
49	160	C.S.		
50	165			
51				167.0-169.0': Interval of trace lignite.
52	170	C.S.		172.0-175.0': Lignite traces.
53	175			
54				178.0-179.0': Lignite traces.
55	180	C.S.	82-167	
56	185			
57				185.0': Lignite traces
58	190	C.S.		
59	195		82-168	192.0-200.0': Interval containing trace lignite.
60				

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-08



Description

TILL: 200.0-206.0'
Light green-grey clay matrix; polymictic pebbles; minor to moderate amount of grit; clasts consist of quartz, limestone, chert, and basement; clay matrix strongly calcareous.

GRAVEL: 206.0-237.0'
Sandy pebbly gravel; polymictic.
209.0': Sedimentary boulder.

TILL: 237.0-239.0'
Light green-grey clay, polymictic pebbles; minor to moderate grit.

CLAY: 239.0-240.0'
Very dark grey clay band.

GRAVEL: 240.0-253.0'
Very sandy pebbly gravel; polymictic; lignite traces until 247.0'.

247.0-252.0': Lignite chips comprise ≃15–30%.

252.0-253.0': Trace lignite.

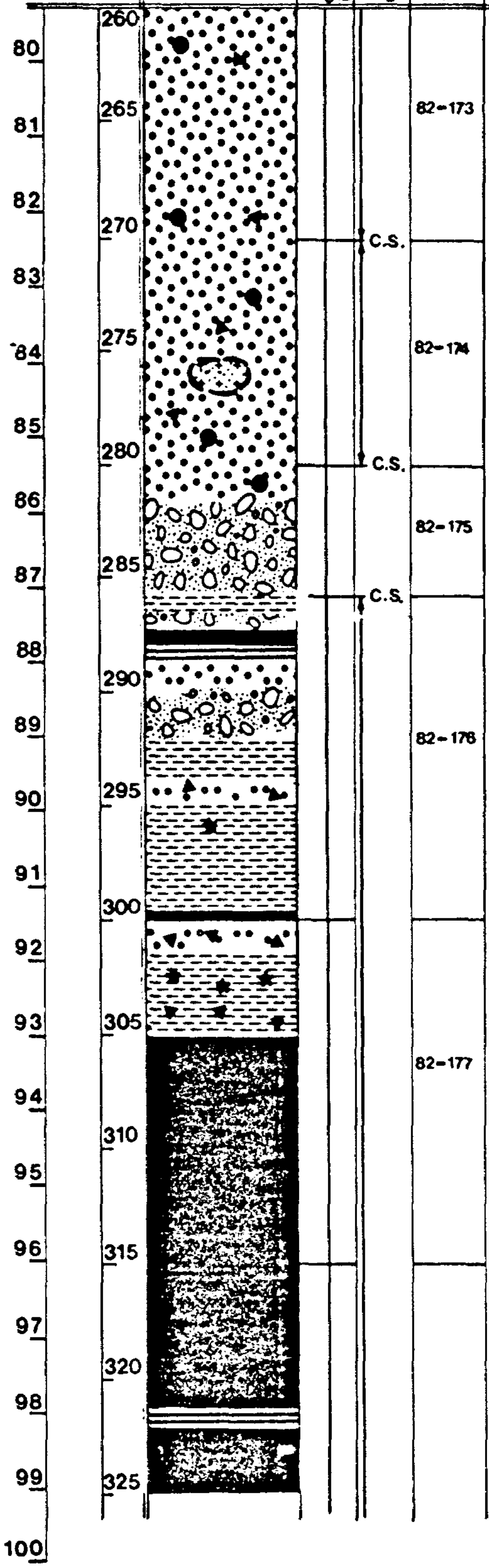
SAND: 253.0-258.0'
Fine- to coarse-grained sand, abundant polymictic pebbles; trace lignite.

GRAVEL: 258.0-282.0'
Very sandy pebbly gravel; polymictic dominantly quartz.
259.0': Trace lignite.

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-08

DEPTH (m / ft)	GRAPHIC LOG	Sampling (reverse circulation interval / % core recovered / Number)	Description



262.0': Trace lignite 1–2%.

267.0-272.0': Trace lignite.

274.0': Trace lignite <1%.
275.0': Sedimentary boulder — limestone.
277.0': Cobble; basement and sedimentary.
278.0': Trace lignite <1%.

TILL: 282.0-286.0'
Dark grey clay with polymictic pebbles; minor sand, calcareous clay. Minor dark grey gritty clay seam (½' thick) at 284.0'.

PLEIST.
CRETAC.

CLAY: 286.0-287.0'
Dark grey-black clay; minor grit.

LIGNITE: 287.0-287.8'
Lignite comprises 80% of sample grading into dark grey-black clay by 287.5'.

SAND/CLAY SEQUENCE: 287.8-304.0'
Polymictic medium- to coarse-grained micaceous sand interbedded with dark grey, gritty, slightly calcareous clay. Clay and sand becoming pyritiferous by 299.0'.
299.0-299.5': Lignite seam; 90% lignite chips occurring in sand seam as above.

LIGNITE: 304.0-321.0'
Conspicuous blebs of pyrite occurring with lignite. Pyrite pseudomorphing of lignite chips is common within the interval. Minor fine-grained sand is associated with the lignite.

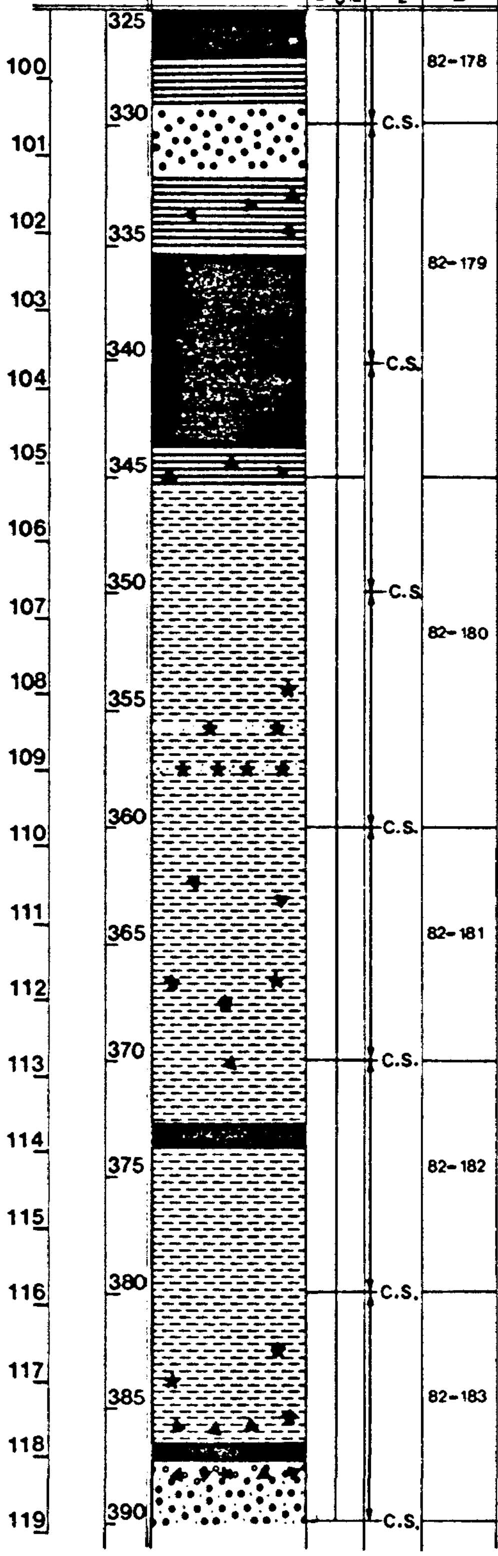
CARBONACEOUS CLAY: 321.0-321.5'
Very soft slightly gritty dark grey-black clay containing lignite chips.

LIGNITE: 321.5-326.5'
Lignite with 15% pyrite blebs as above. Dark brown wood chips also present.

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole №: ONEX-82-08

DEPTH m ft	GRAPHIC LOG	Sampling: reverse circulation interval	% core recovered	Number	Description



CARBONACEOUS CLAY: 326.5-328.5'
Very gritty, medium stiff, woody texture contains ≈10% disseminated flecks of pyrite. 1–2" seam of gravel/sand noncalcareous dominantly quartz and chert with minor clay.

PEBBLE SAND: 328.5-331.0'
Bimodal; very fine-grained light beige dominantly quartz sand (noncalcareous); pebbles subrounded to subangular — quartz, chert, pyrite, and lignite.

CARBONACEOUS CLAY: 331.0-334.0'
Very soft, slightly gritty clay containing lignite chips.

LIGNITE: 334.0-343.0'
As above with 10% pyrite blebs.

CARBONACEOUS CLAY: 343.0-344.5'
As above.

CLAY: 344.5-385.5'
Light to dark grey, noncalcareous, non-gritty to gritty soft to moderately stiff clay. Clay may contain lignite chips, quartz sand, and/or pyrite as blebs or disseminated crystals. Minor mottling and varves may be observed at 353.0'.

356.5-356.6':	Sandstone rich in pyrite occurring as blebs and disseminated grains. Lignite comprises ≈15% of sample.
356.6-357.0':	Layer of pyrite ≈½' thick.
372.0':	Lignite — 2-3" seam containing pyrite blebs.
376.0-378.0':	Light green-grey clay.
378.0-382.0':	White and light grey pyritiferous clay with a very fine sand coating and minor black mottling.

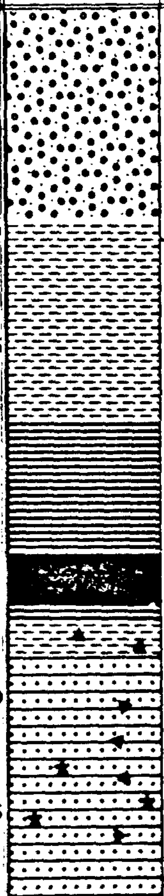
LIGNITE: 385.5-386.5'
Lignite (≈80%) occurs with pyrite blebs (≈20%). Minor coarse-grained sand is introduced at 386.0'.

LIGNITE AND SAND: 386.5-387.5'
Coarse-grained quartz sand comprises ≈40% of sample, lignite 50% of sample, and pyrite ≈10%.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole No: ONEX-82-08

Sheet 7 of 7

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number
119–139	390–455		387.5–400 (approx.)	90; 60; 60	82-185A

Description

SILICA SAND: 387.5-398.1'
Fine to coarse silica sand with lignite initially comprising ≈10% of sample and gradually diminishing to trace amounts by 389.0'. Minor pyrite blebs.
392.0-393.0': Lignite ≈40%.

CLAY/CLAYSTONE: 398.1-408.0'
Dark chocolate, non-gritty clay grading into medium grey, slightly gritty, lignitic clay by 400.0'. Content of lignite, wood chips, and disseminated pyrite increases with depth.

CARBONACEOUS CLAY: 408.0-413.5'
Black slightly gritty, noncalcareous clay containing minor disseminated pyrite.

LIGNITE: 413.5-416.0'
Lignite contains pyrite occurring as blebs, convolute structures, and pseudomorphs of lignite chips. Very minor amount of fine-grained sand imparts grittiness to lignite.

CARBONACEOUS CLAY: 416.0-416.5'
Dark grey gritty clay with abundant lignite and dark brown woody chips.

CLAY/CLAYSTONE WITH SAND: 416.5-428.0'

416.5-417.5': Light beige-grey, noncalcareous, slightly gritty clay containing lignite chips; woody texture revealed upon breaking.

417.5-422.2': Light grey clayey sand containing minor pyrite as disseminated crystals and larger blebs, and lignite chips.

422.2-428.0': Medium grey, gritty (sandy) clay with lignite and wood chips; very minor disseminated pyrite; muscovite imparts waxy texture to clay after 427.5'.

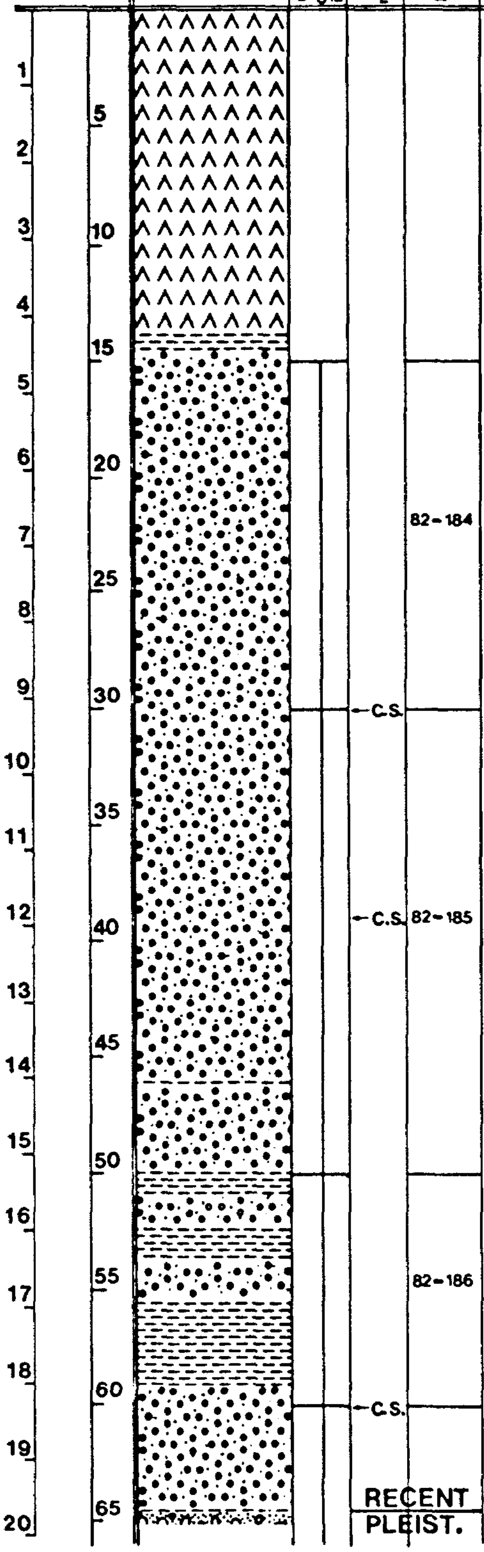
428.0': END OF HOLE

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole No: ONEX-82-09 Location: NORTHWEST RAPLEY TWP.

Elev. of collar: 308 ft Sheet 1 of 6 (lat. 50°27'00" N long. 87°02'53" W)

DEPTH (m, ft)	GRAPHIC LOG	Sampling (reverse circulation interval, % core recovered, Number)	Description



MUSKEG: 0-14.0'

SAND AND GRAVEL: 14.0-49.0'
Unit starts with thin clay layer; predominantly fine polymictic sand. Rock fragments mostly sedimentary (60%); limestone light grey and brown fossilferous, black siltstone pebbles; basement 40% diabase and granite.

40.0-50.0': Mostly sedimentary rocks; 90% sedimentary, 10% basement.

CLAY: 49.0-58.0'
Light brown calcareous, slightly gritty, stiff; occasional black siltstone sandy intervals.

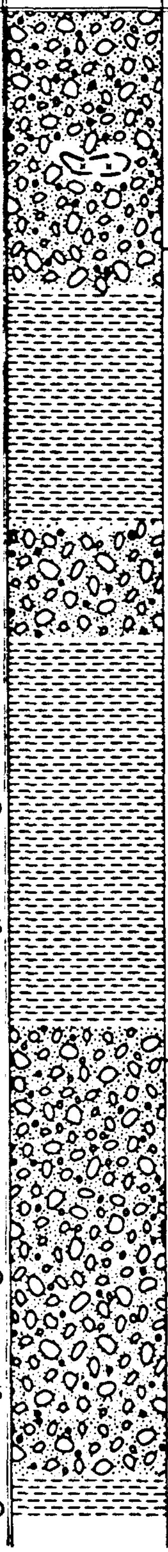
SAND, GRAVEL AND COBBLES: 58.0-64.0'
Brown limestone.

SANDY CLAY TILL: 64.0-77.0'
Moderate sand 10-20%, grey-green calcareous clay. Rock fragments include sedimentary 60% - limestone chert, jasper, black siltstone; basement 40% - diabase and granite.

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-09

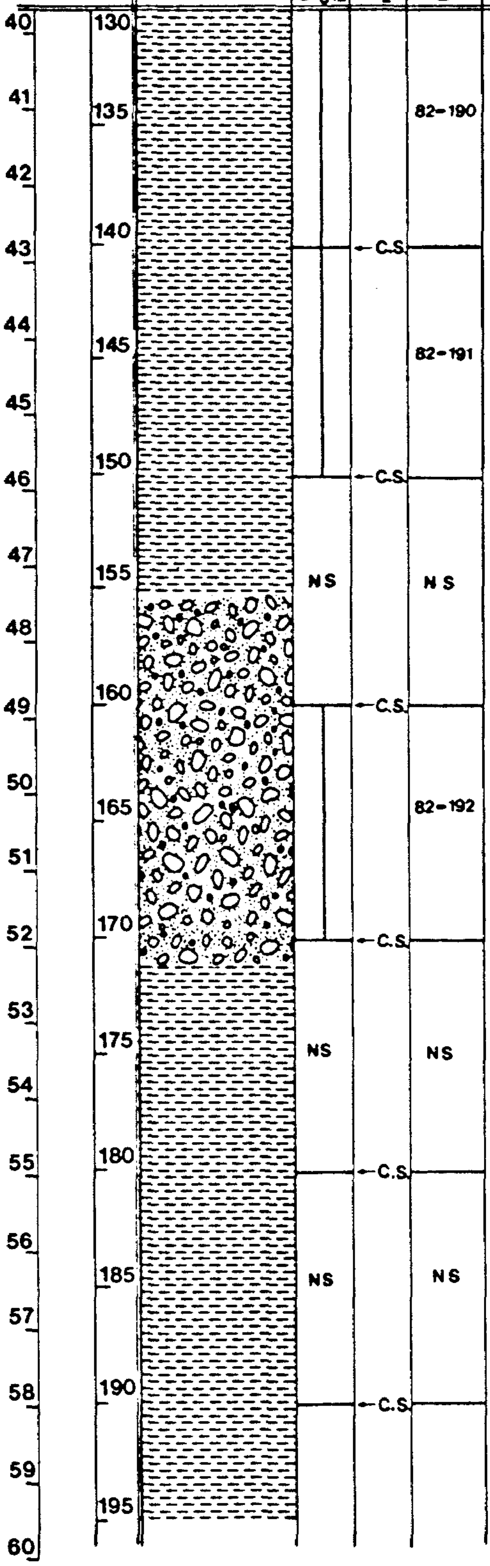
Sheet 2 of 6

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
20	65					
21	70			C.S.	82-187	
22						71.5-72.0': Diabase boulder.
23	75					
24	80			C.S.		CLAY: 77.0-82.0' Stiff, medium grey, slightly calcareous to 79.0' then non-calcareous.
25						
26	85					CLAY: 82.0-87.0' Soft, grey-green calcareous clay; becomes stiff by ≈84.0'; occasional pebble. 85.5': ½" sand.
27	90			C.S.		CLAY TILL: 87.0-92.0' Grey-green, calcareous clay with minor polymictic sand and angular rock clasts; predominantly limestone.
28			NS		NS	CLAY: 92.0-94.0' Light brown, calcareous, moderate stiffness.
29	95					CLAY: 94.0-108.0' Stiff green-grey clay, calcareous, slightly gritty, occasional sedimentary or diabase pebbles.
30	100					
31				C.S.		
32	105					
33						
34	110			C.S.		CLAY TILL: 108.0-128.0' Soft, grey-green clay with rounded to subangular limestone and basement pebbles. Minor sedimentary fraction.
35	115				82-188	
36						
37	120			C.S.		
38	125				82-189	
39						CLAY: 128.0-155.0' Green-grey clay; extremely calcareous, minor grit, few limestone, jasper and basement fragments/pebbles.
40	130			C.S.		

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-09

DEPTH m ft	GRAPHIC LOG	Sampling: reverse circulation interval	% core recovered	Number	Description



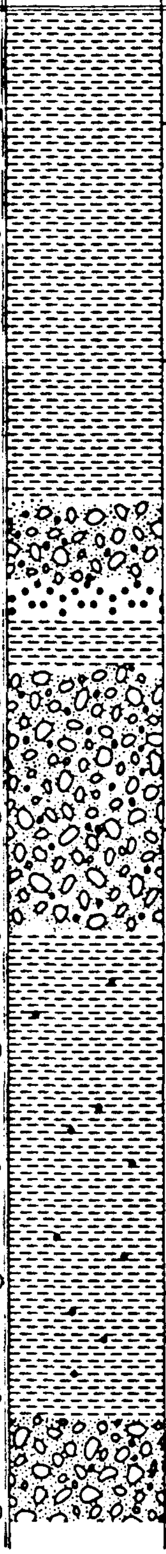
CLAY TILL: 155.0-170.0'
Green-grey clay till, calcareous, minor grit; sedimentary dominantly limestone and basement pebbles.

CLAY: 170.0-215.0'
Light green-grey clay, calcareous, non-gritty.

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-09

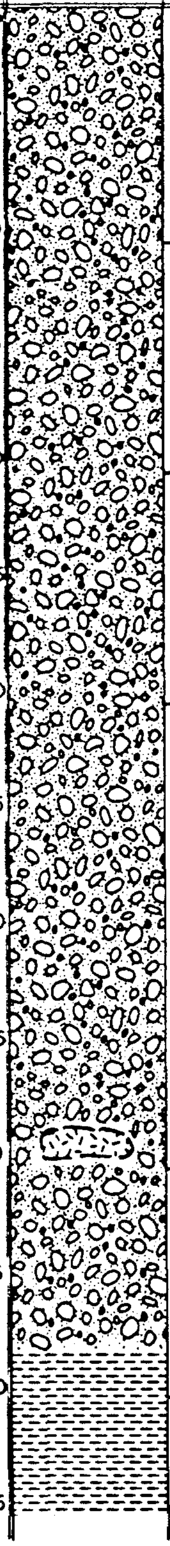
DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
60	195		NS		NS	
61	200			← C.S.		
62–64	205–210		NS		NS	
65–70	215–230			← C.S. (220)	82-193	TILL: 215.0-219.0' Grey-green clay matrix, calcareous; clasts are sedimentary (jasper, limestone) and basement (diabase, quartz, mafics); also contains fine sand. GRAVEL: 219.0-220.0' Pebbly gravel with very minor grey-green clay matrix; pebbles both basement and sedimentary. CLAY: 220.0-222.0' Same as 170.0-215.0'. TILL: 222.0-234.0' Grey-green calcareous clay matrix, minor sand. Basement clasts ≈60%; sedimentary clasts ≈40%.
71–76	235–250			← C.S. (240); ← C.S. (250)	82-194	CLAY: 234.0-255.0' Green-grey calcareous clay; no sandy component; contains a few pebbles, both sedimentary and basement.
77–80	255–260					TILL: 255.0-316.0' Green-grey calcareous clay, containing basement (granite and diabase) and sedimentary (limestone, chert) clasts; minor quartz; trace of dark brown wood pieces. Sand in return is very fine-grained polymictic, very calcareous, light green in colour (probably due to presence of clay particles in sand). Light green-grey clay is very gritty, very calcareous medium stiff. Amount of clastic material varies.



1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

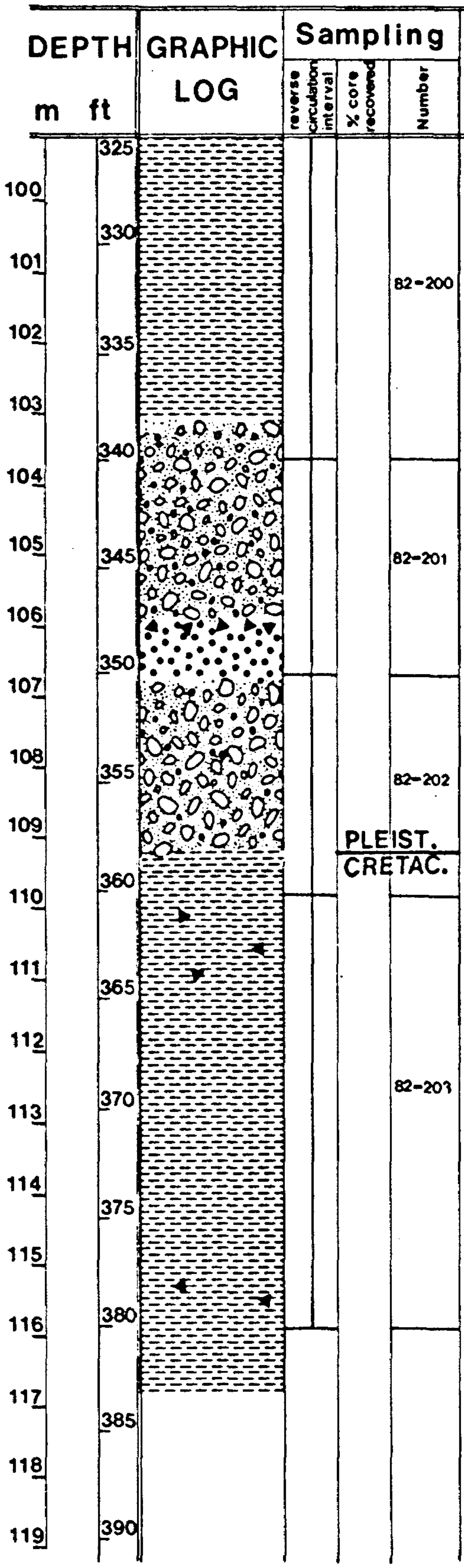
Drill Hole Nº: ONEX- 82- 09

Sheet 5 of 6

DEPTH m	ft	GRAPHIC LOG	Sampling: reverse circulation interval	% core recovered	Number	Description
80	260					Till may be dominantly clay with little or no clastic material or may contain pebble-sized angular fragments (possibly a cobble).
81	265				82-195	
82	270			C.S.		
83						
84	275				82-196	
85	280			C.S.		
86						
87	285				82-197	
88	290			C.S.		
89						
90	295					
91	300			C.S.	82-198	
92						
93	305					
94	310					307.5-309.0': Granite boulder.
95						
96	315				82-199	
97	320			C.S.		CLAY: 316.0-336.0' Sandy component in till is diminishing; sample becoming predominantly a clay; slightly gritty, calcareous, medium stiff with <10% clastic material; still green-grey in colour.
98						
99	325					
100						

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-09



Description

CLAY: 336.0-336.2'
≈3" seam of chocolate brown clay.

TILL: 336.2-346.0'
Grey-green calcareous clay with 70% sedimentary fragments (limestone, chert, jasper) and 30% basement (diabase, granite); clay matrix, very gritty; only moderate amount of sand.
346.0-346.1': Large lignite chips (≈20% of sample).

SAND: 346.1-348.0'
Fine to coarse polymictic sand.

TILL: 348.0-358.0'
Medium to dark grey clay till; calcareous and very gritty. Till contains moderate amount of sand; sedimentary and basement clasts present. Becoming noncalcareous by 349.0' with minor yellow mottling. Minor quartz grains present.
351.0-358.0': Dominantly sedimentary clasts in dark grey-brown clay with minor sandy component.

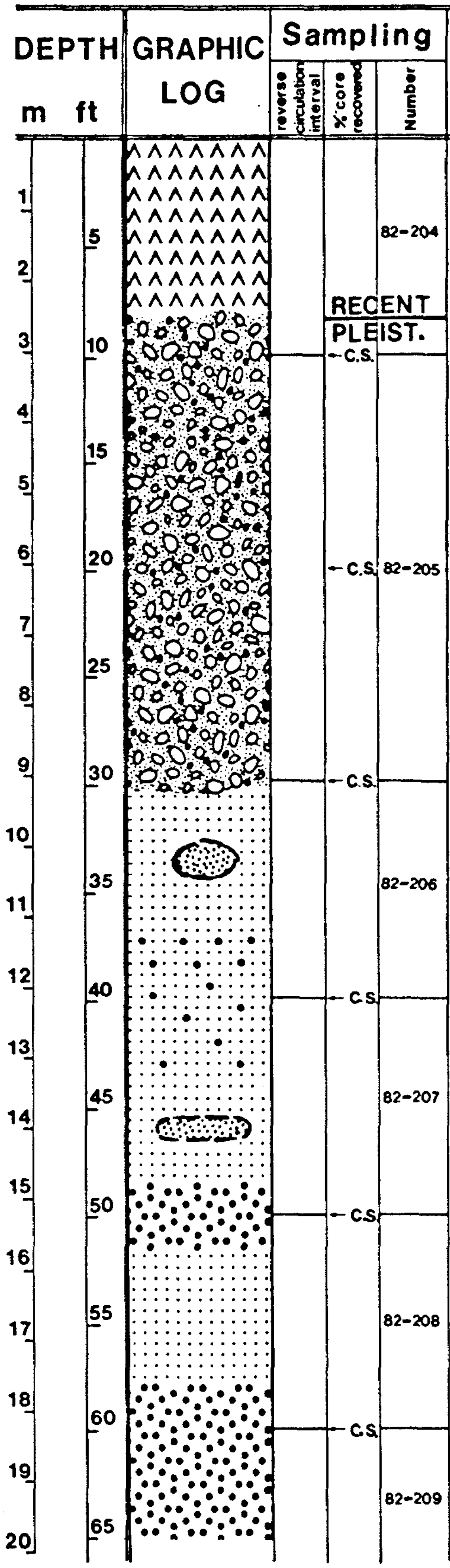
VARIEGATED CLAY: 358.0-383.0'
Alternating layers of yellow, red, green-grey, dark grey, and brown-grey clay; noncalcareous, dominantly non-gritty, with minor mottling. Clays contain trace amounts of lignite.

383.0': END OF HOLE

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-10 Location: NORTHERN ACRES TWP.

Elev. of collar: 325 ft Sheet 1 of 7 (lat. 50°13'01"N long. 82°22'03"W)



Description

MUSKEG: 0-8.0'

CLAY TILL: 8.0-30.0'

Light grey-green clay till; polymictic pebbles; clay matrix soft, calcareous, moderate amount of sand; pebbles comprised of sedimentary limestone, chert, and jasper 90%, and basement 10%.

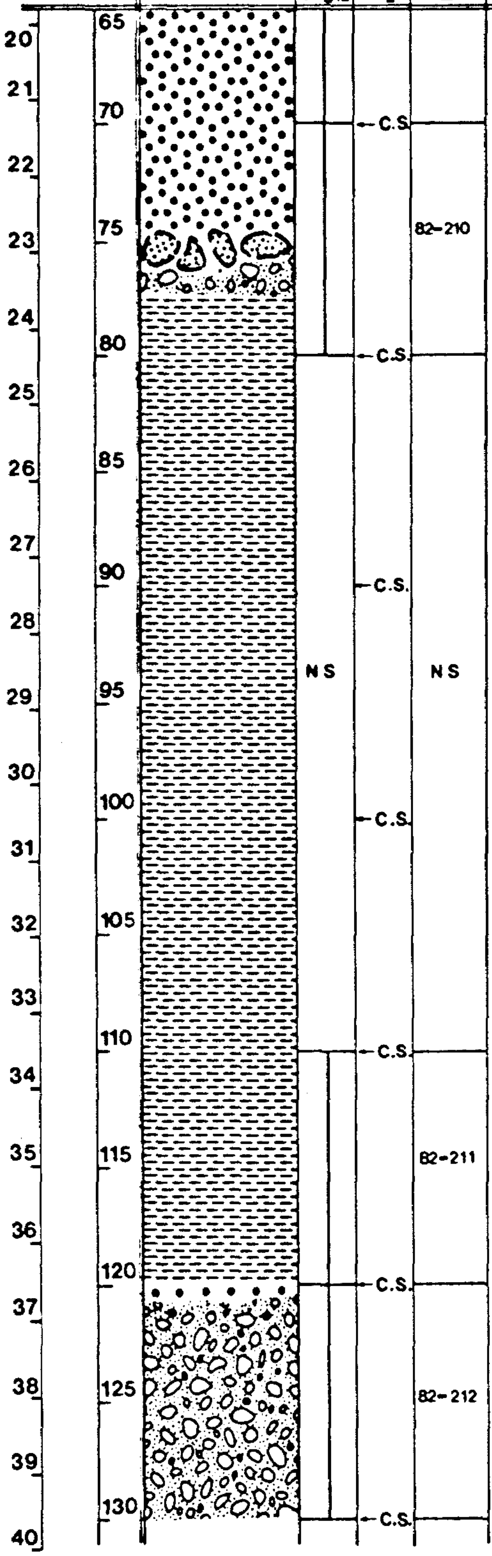
SAND AND GRAVEL: 30.0-76.0'

30.0-35.0':	Sandy gravel; polymictic with a sedimentary boulder at 34.0'.
35.0-35.5':	Pebbly sand; ½' thick seam; polymictic with lignite traces.
35.5-40.0':	Sandy gravel.
41.0-48.0':	Polymictic sand with a sedimentary boulder at 46.0'.
48.0-51.0':	Sandy gravel; sedimentary clasts ≈90%, basement ≈10%, polymictic sand and gravel.
51.0-57.0':	Polymictic sand; fine- to coarse-grained, few sedimentary and basement pebbles.
56.0':	Sedimentary boulder.
57.0-60.0':	Very sandy gravel; polymictic; minor quartz.
60.0-68.0':	Fine to coarse sand; polymictic.

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-10

DEPTH (m, ft) | GRAPHIC LOG | Sampling (reverse circulation interval, % core recovered, Number) | Description



68.0-72.0': Very sandy gravel, polymictic sand and gravel.
69.0': Trace lignite.
72.0-73.0': Pebbly sand fine- to coarse-grained, polymictic sedimentary clasts ≈50%; basement ≈50%.
73.0-76.0': Very sandy gravel, angular to subrounded clasts; quartz, chert, granite, limestone, diabase, basic; sedimentary ≈50%, basement ≈50%.
74.0': Lignite trace and brown wood pieces.
75.0': Sedimentary boulders.
76.0': Lignite trace.

CLAY TILL: 76.0-77.0'
Light grey-green, calcareous, moderate hardness; clasts predominantly sedimentary.

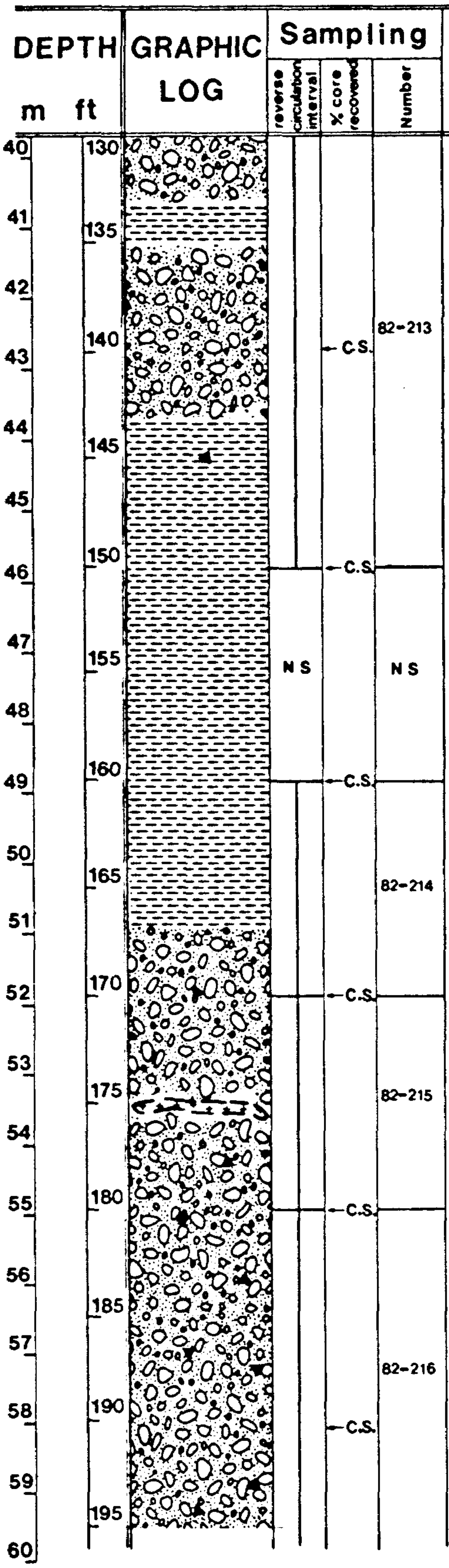
CLAY: 77.0-121.0'
Medium grey-green clay; calcareous; minor grit; minor amount of sedimentary fragments and basement pebbles; occasional lignite chips.
93.0': ≈1% dark basement pebbles, angular.

108.0': Clay becomes stiffer.

CLAY TILL: 121.0-133.0'
Grey-green clay till (≈80% clay); minor grit; strongly calcareous. By 125.0' increase in large angular limestone fragments. Occasional lignite chips.

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-10



Description

CLAY: 133.0-135.0'
Green-grey, calcareous, moderately hard; few pebbles.

CLAY TILL: 135.0-143.0'
Same as 121.0-133.0'. 50% sedimentary pebbles (chert), 50% basement (diabase, quartz, greenstone). Minor lignite.

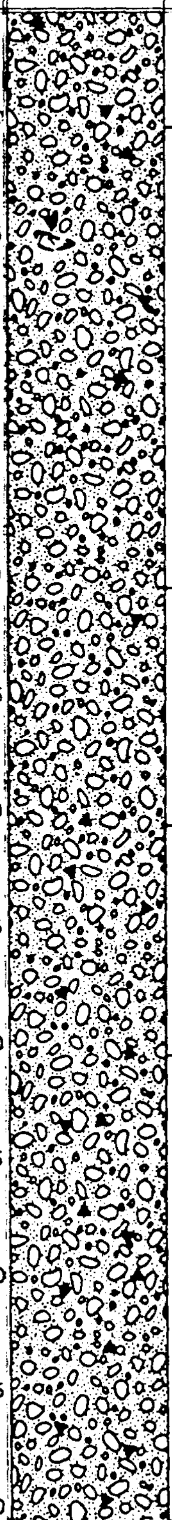
CLAY: 143.0-167.0'
Grey-green clay, calcareous, minor grit, few pebbles (50% sedimentary, 50% basement).

CLAY TILL: 167.0-268.0'
Similar to 135.0-143.0'. Green-grey, calcareous, minor grit; predominantly medium sand. Sedimentary fragments 50%, basement fragments 50%; angular to subrounded. Minor lignite.

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

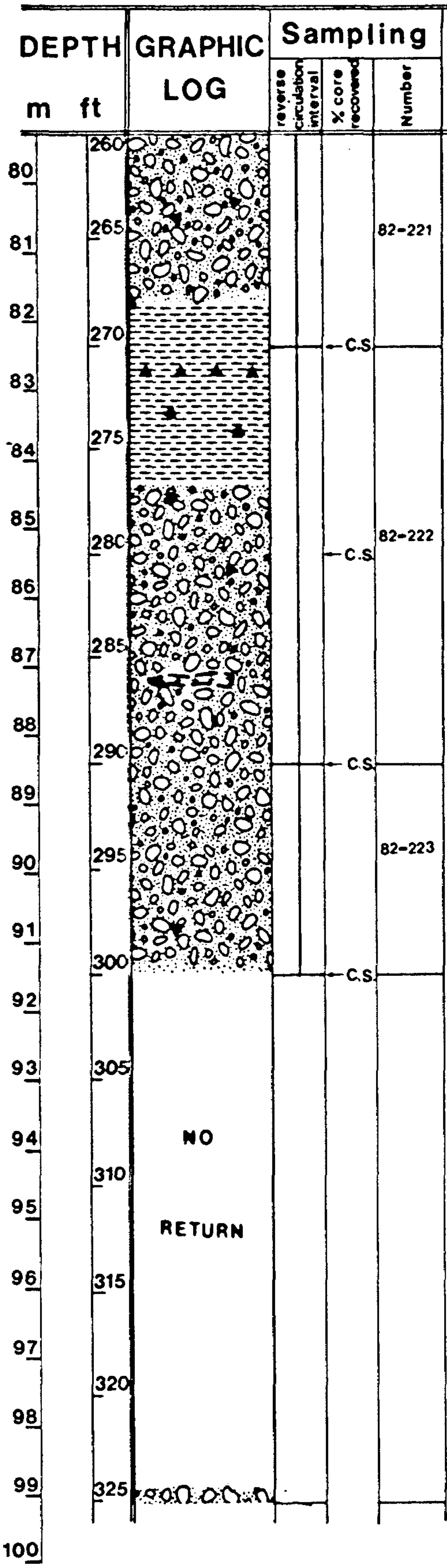
●ill Hole Nº:ONEX- 82 - 10

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
60	195					
61	200			←C.S.		
62						
63	205					205.0': Granite cobble.
64	210			←C.S.	82-217	
65						
66	215					
67	220			←C.S.		
68						
69	225				82-218	
70	230			←C.S.		
71						
72	235				82-219	
73	240			←C.S.		240.0-246.0': Little material returned; some fine sand.
74						
75	245					246.0': Good return; 30% material is lignite, 30% wood chips, and 40% till.
76	250			←C.S.	82-220	246.0-249.0': >1% lignite.
77						
78	255					
79	260			←C.S.		
80						



1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX- 82 - 10



Description

263.0': Pyrite blebs <1%.

CLAY: 268.0-277.0'
Medium grey-green clay, soft, calcareous with small amount of fine sand. Few diabase and limestone pebbles.
271.0': Lignite ≈10% of return.

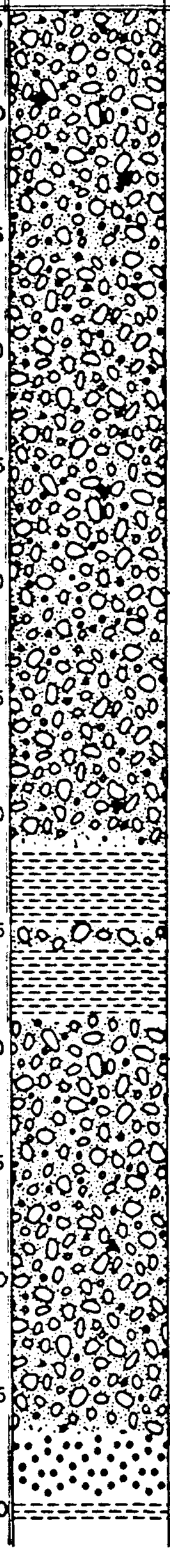
CLAY TILL: 277.0-300.0'
Same as 167.0-268.0'.

286.0': Boulder – basement.

300.0-325.0': No sample return. Drive casing and dual tubes together. Sanded.

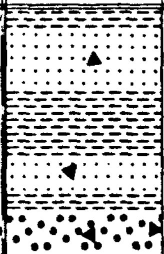
1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX- 82- 10

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
100	325					CLAY TILL: 325.0-362.0' Medium green-grey, slightly gritty, calcareous clay. Pebbles are predominantly black siltstone and granite — rounded to angular; 15-20% of pebbles are angular beige limestone. Sand fraction is polymictic. Till contains trace lignite and wood chips.
101	330			C.S.		
102	335				82-224	
103						
104	340			C.S.		
105	345					
106						
107	350			C.S.		
108	355					355.0': Minor shell fragments.
109					8?-259	357.0-358.0': Small boulders.
110	360			C.S.		CLAY: 362.0-364.0' Stiffer green-grey calcareous clay; very minor grit.
111	365					CLAY TILL: 364.0-365.0' As above.
112						CLAY: 365.0-368.5' Same as 362.0-364.0'; no grit.
113	370			C.S.		CLAY TILL: 368.5-378.0' Softer green-grey calcareous clay with minor grit. Contains fragments of beige limestone and 10-15% diabase. Trace detrital lignite.
114	375					
115					82-225	CLAY: 378.0-379.5' Moderately stiff, calcareous, medium grey-green clay.
116	380			C.S.		CLAY TILL: 379.5-386.0' Same as 368.5-378.0'.
117	385					SAND AND CLAY SEQUENCE: 386.0-400.0' Sand is polymictic and fine-grained containing trace lignite and abundant mafics; becoming coarser-grained with 10-15% lignite at 400.0'. Clay interbeds included in interval.
118						
119	390			C.S.		389.0-391.0': Medium grey-green, sandy calcareous, very compact clay. Possibly also mudstone.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX- 82 - 10

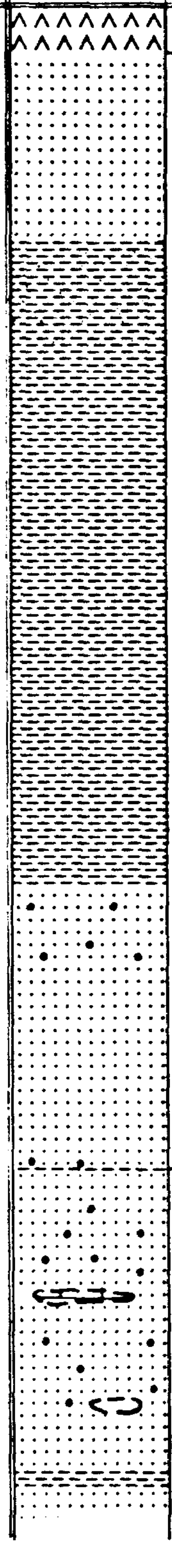
DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
119–120	390					393.0-396.0': Soft, light brown calcareous clay.
120–121	395				82-226	
121–122						397.0-398.0': Clay as above.
122	400					400.0': END OF HOLE.

Depth scale: m 119, 120, 121, 122, 23, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139; ft 390, 395, 400, 405, 410, 415, 420, 425, 430, 435, 440, 445, 450, 455

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-11 Location: SOUTHWEST ACRES TWP.

Elev. of collar: 331 ft Sheet 1 of 6 (lat. 50°08'50" N long. 82°25'23" W)

DEPTH (m / ft)	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
0–20 m / 0–65 ft			C.S. (at approx. 1, 3, 6, 9, 12, 15, 18.5 m)	82-227; 82-228	see below

RECENT / PLEIST. (boundary at 38.0')

MUSKEG: 0-2.0'

CLAY: 2.0-3.0'
Light brown, calcareous.

FINE SAND: 3.0-11.0'
Very fine-grained, polymictic. Minor shell fragments. Includes clasts of beige limestone and dark basement rocks.

CLAY: 11.0-12.0'
Soft, grey-green, calcareous.

CLAY: 12.0-38.0'
Soft, medium to dark grey. Moderate sand content to 15.0', then minor. Occasional shell fragments. Few rock fragments.

30.0-32.0': Moderate amount of shell fragments.

SAND: 38.0-46.0'
Fine-grained, polymictic. Pebbles - 80% limestone, 20% basement. Light brown water.

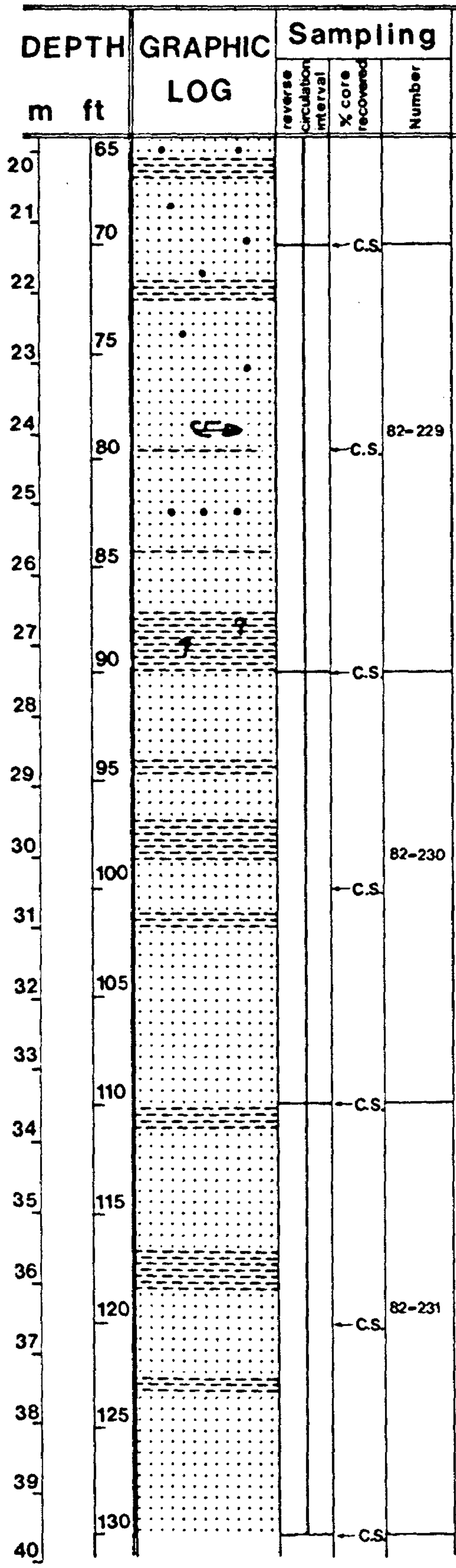
SAND AND GRAVEL: 46.0-182.0'
Very fine-grained to fine-grained polymictic sand; calcareous; minor sericite. Gravel consist of light coloured limestones, black siltstone, granite and diabase. Unit has occasional thin, hard, silty clay layers.

55.0-56.0': Limestone boulder.

63.0-64.0': Light brown calcareous sandy clay.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

●rill Hole Nº: ONEX-82-11

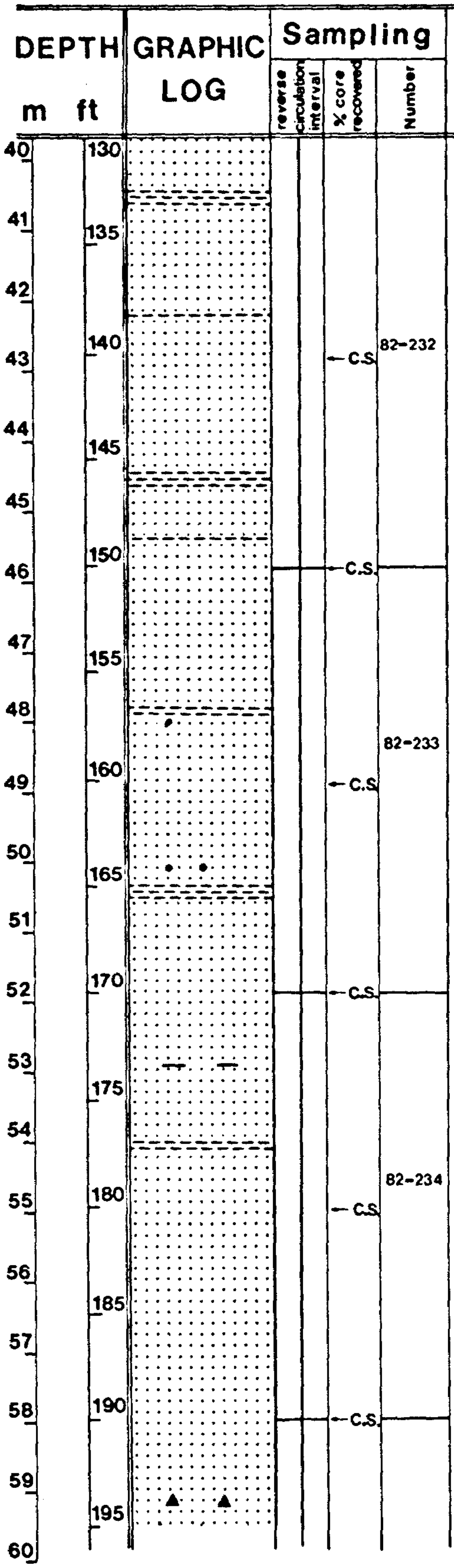


Description

72.0-73.0':	Light brown calcareous sandy clay.
77.0-78.0':	Limestone boulder.
82.0':	Minor gravel; 80% sedimentary (beige limestone, black siltstone), 20% basement (predominantly granite).
87.0-90.0':	Very little sample returned. Washing very soft clay?
94.0-95.0':	Soft, medium grey, calcareous clay.
97.0-99.0':	Clay; same as 94.0-95.0'.
110.0-111.5':	Stiff medium grey calcareous clay.
117.0-118.0':	Stiff medium grey calcareous clay.
118.5-118.6':	Same as 117.0-118.0'.
123.0-124.0':	Moderately stiff medium grey calcareous clay.

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-11



Description

133.0-134.0': Medium grey, calcareous clay.

146.0-147.0': Medium grey, calcareous clay.

164.0': Organic matter; few limestone clasts followed by medium grey calcareous clay.

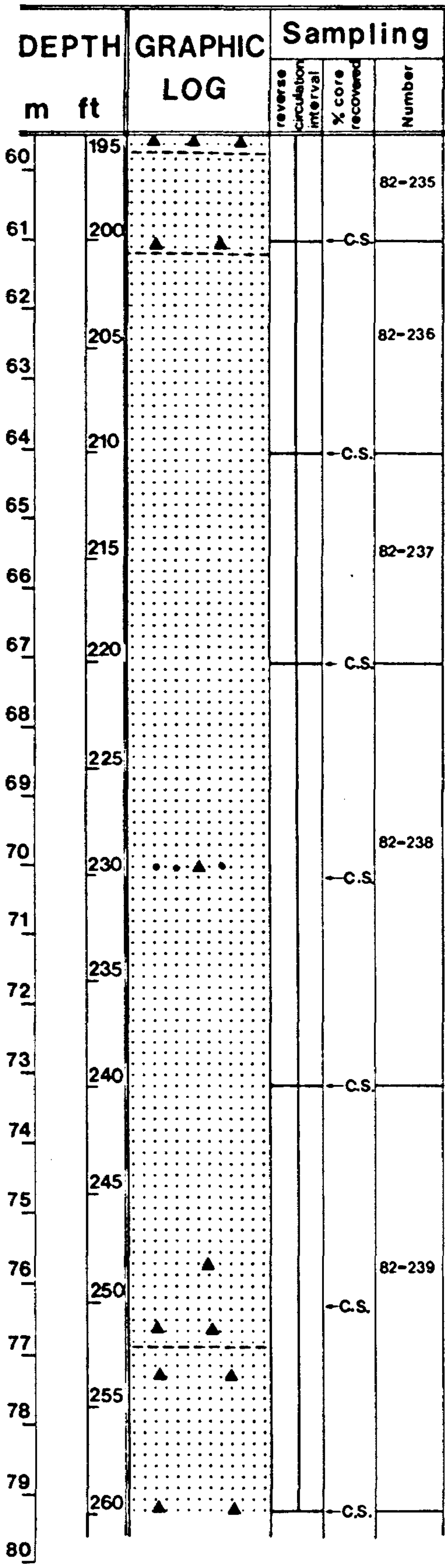
177.5-178.0': Medium grey-green calcareous clay; slightly gritty.

FINE SAND: 182.0-204.0'
Light brown, fine-grained, calcareous sand; polymictic; 10-15% dark grains; occasional organic matter.

193.0': Minor lignite and organic matter.

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-11



Description

196.0': Minor lignite with clay; few wood chips; possible thin seam with underclay?

201.0': Lignite chips and organic matter with light grey calcareous clay.

VERY FINE SAND: 204.0-229.0'
Very fine-grained calcareous sand; polymictic; minor organic matter.

225.0': Organic matter.

GRAVEL: 229.0-229.5'
Pebbles and cobbles of sedimentary and basement origin. Minor lignite.

VERY FINE SAND: 229.5-253.0'
Same as 204.0-229.0'.

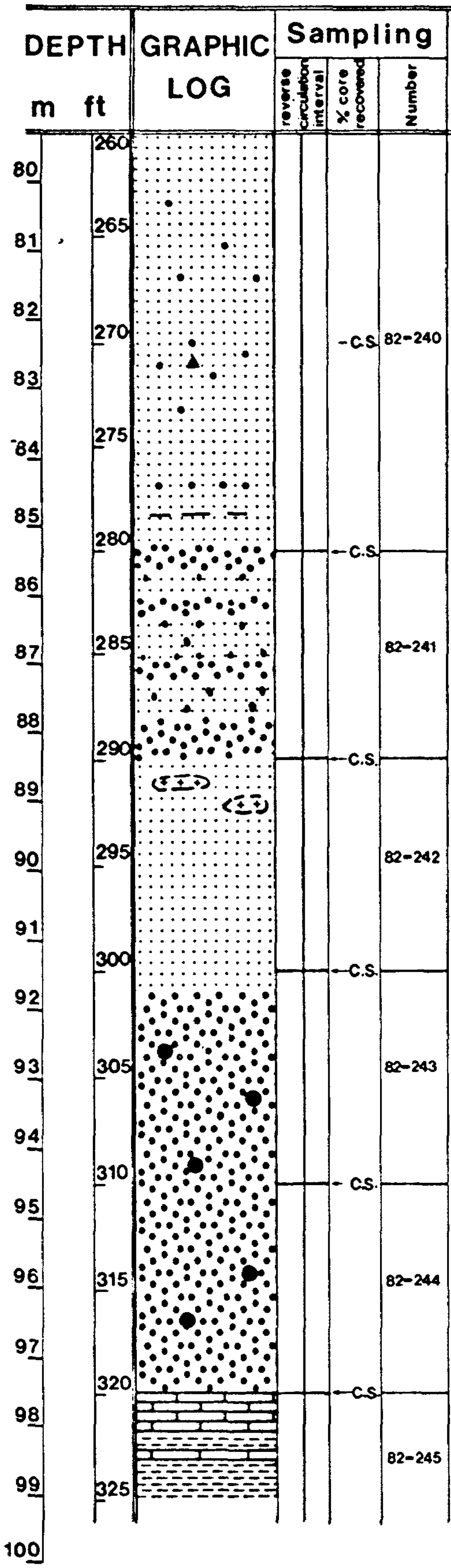
FINE SAND: 253.0-272.0'
Same as 182.0-204.0', with minor lignite and wood chips.

260.0': Minor lignite, wood chips, and organic matter.

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-11

Sheet 5 of 6



Description

FINE SAND: 272.0-280.0'
With small pebbles; minor lignite and organic matter.

GRADED SEQUENCE: 280.0-290.0'
Appears to be graded in thin beds. Repeated sequence of fine sand, medium sand, sometimes coarse sand, pebbles with lignite.

COBBLES AND BOULDERS: 290.0-293.0'
Sedimentary rocks include limestone, chert, and siltstone. Basement materials include granite and diabase. Minor wood chips present.
291.0': Boulder; dark green mafic with minor quartz.

FINE TO MEDIUM SAND: 293.0-301.5'
Medium to dark grey, polymictic, fine- to medium-grained. Contains high percentage of mafic particles. Very calcareous; possibly due to occurrence of white shell fragments. Sand grains are subangular to subrounded. Submature sand. Limestone/dolomite abundant quartz, grey chert, and jasper.
301.0-301.5': Boulder; light grey limestone.

PEBBLE SAND: 301.5-306.0'
Rounded to subangular fragments, polymictic clasts consist of quartz, white and grey chert, jasper, and basement fragments. Predominantly grey limestone; minor lignite. Unit very calcareous. Bimodal; pebbles and medium-grained sand.

COBBLES(?): 306.0-320.0'
Medium grey, angular limestone fragments; minor grey chert; sand similar to 301.5-306.0'.

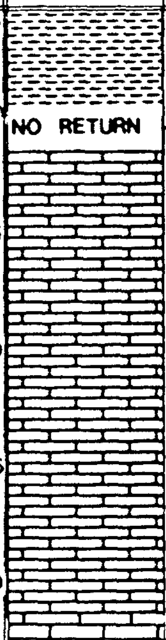
PLEIST.
DEVON.

LIMESTONE: 320.0-323.0'
Medium-light beige-grey angular fragments.

TRANSITIONAL: 323.0-330.0'
323.0-323.2': Brown calcareous, very gritty siltstone.
323.2-323.9': Limestone (same as 320.0-323.0').

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole No: ONEX-82-11

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number
100	325, 330			cs	
101		NO RETURN		0	
102–104	335, 340			75	
105–107	345, 350			100	
108–119	355, 360, 365, 370, 375, 380, 385, 390				

Description

323.9-324.0': Dark grey clay, slightly gritty, soft, calcareous.

324.0-325.0': Siltstone, medium grey, gritty, slightly calcareous.

325.0-327.0': Clay, medium grey, soft, noncalcareous, slightly gritty. Sand occurring with clay is very fine-grained, medium grey, polymictic, very calcareous.

327.0-327.5': Medium grey claystone/siltstone in clay; both highly calcareous.

327.5-330.0': Dominantly medium grey siltstone, slightly calcareous (opposed to above); absence of clay evident.

LIMESTONE: 332.0-352.0'

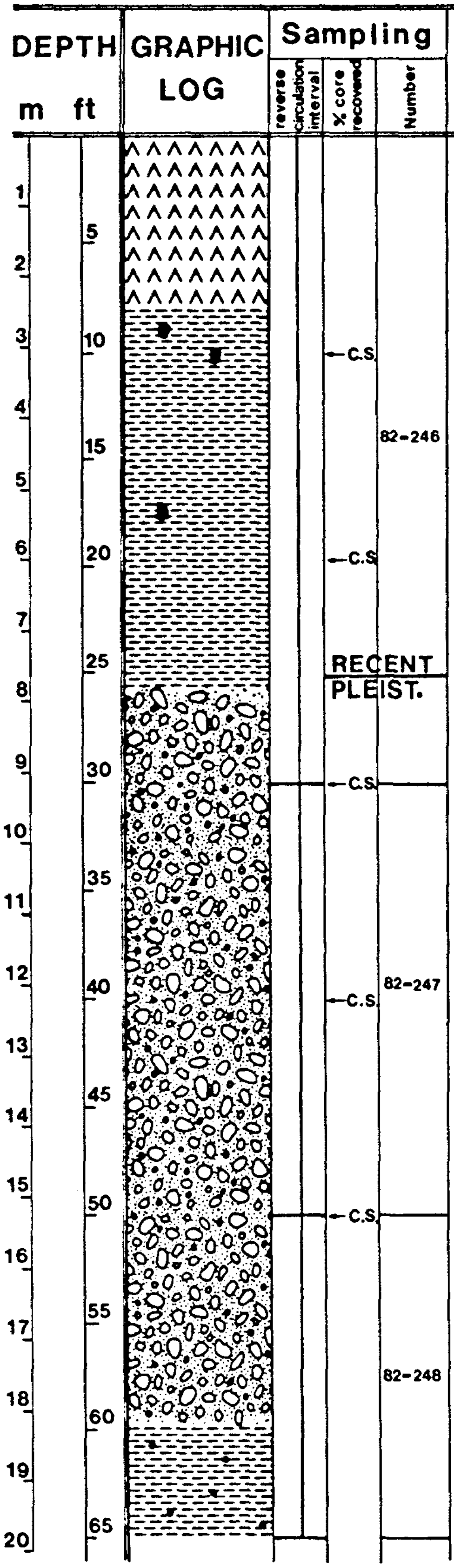
351.1-352.0': Minor flecks of green mineral cover limestone; possibly glauconite.

352.0': END OF HOLE

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-12 Location: SOUTHCENTRAL WRIGHT TWP.

Elev. of collar: 394 ft Sheet 1 of 6 (lat. 50°07'35" N long. 82°35'25" W)



Description

MUSKEG: 0-8.0'

MARINE CLAY SAND GRAVEL: 8.0-25.0'
Green-grey, stiff, calcareous clay; contains shells, limestone pebbles (60%), and basement pebbles (40%).

TILL: 25.0-34.0'
Sandy till, green-grey calcareous clay, sand, pebbles–cobbles.

CLAY TILL: 34.0-59.0'
Green-grey calcareous clay; minor sand fraction (≈5%); 5% mafic specks; 5% pebbles–chert, limestone, jasper, basement.

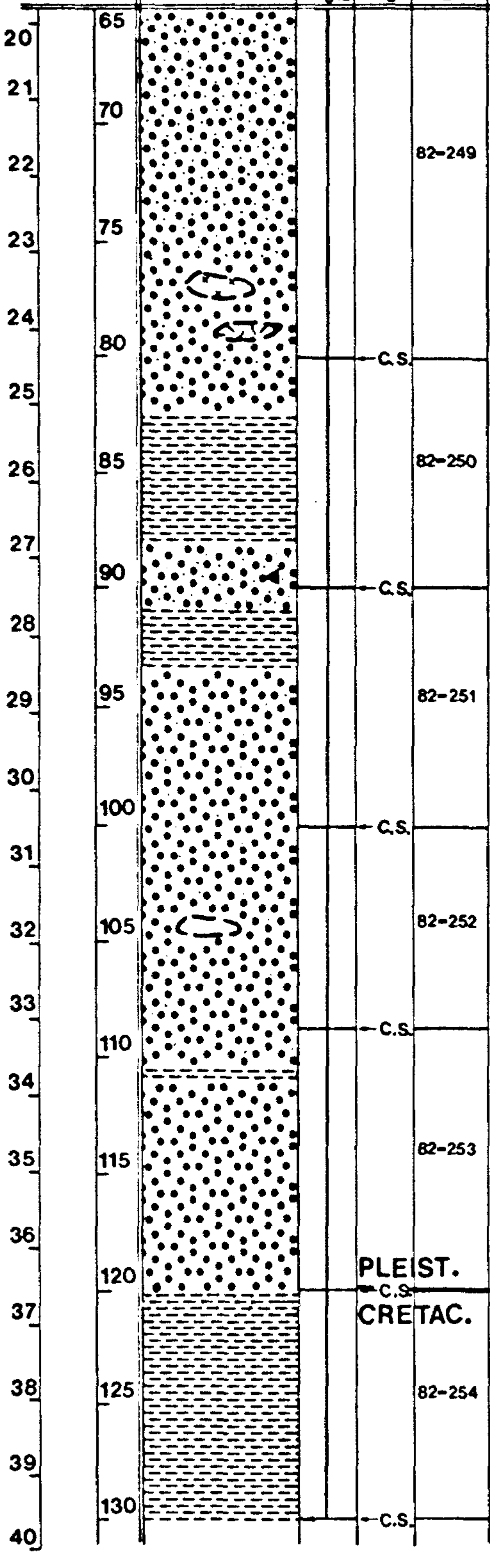
42.0-46.0': Slight increase in sand content, polymictic fine- to medium-grained.

CLAY: 59.0-64.0'
Soft, green-grey, calcareous clay; sand absent, very few pebbles.

FINE SAND: 64.0-78.0'
Polymictic, fine- to medium-grained with pebble layers; calcareous sand; 10% mafics; pebbles consist of 50% sedimentary-limestone, chert, black siltstone; 30% basement-quartz, granite.

Drill Hole Nº: ONEX-82-12

DEPTH (m / ft)	GRAPHIC LOG	Sampling (reverse circulation interval / % core recovered / Number)	Description



77.0': Diabase boulder.
78.0': Granite boulder.
78.0-82.0': Pebbles, cobbles, and boulders.
81.0': Boulder; lots of epidote in fragments, fine to coarse polymictic sand.

CLAY WITH MINOR SAND: 82.0-97.0'

82.0-88.0': Stiff, medium green-grey moderately calcareous clay.
88.0-90.0': Sand; polymictic, fine- to medium-grained; contains wood chips.
90.0-92.0': Same as 82.0-88.0', only slightly calcareous.
92.0-93.0': Chocolate brown clay with wood chips.
93.0-97.0': Clay; green-grey, noncalcareous.

GRAVEL AND SAND: 97.0-120.0'

97.0-108.0': Gravel and sand; cobbles and boulders.
104.0': Boulder.
108.0-110.0': Medium coarse silica quartz sand, light grey minor jasper and mafics (≃5%).
110.0-110.5': Clay.
110.5-120.0': Quartz sand; graded quartz sands, pebble unit mixed.

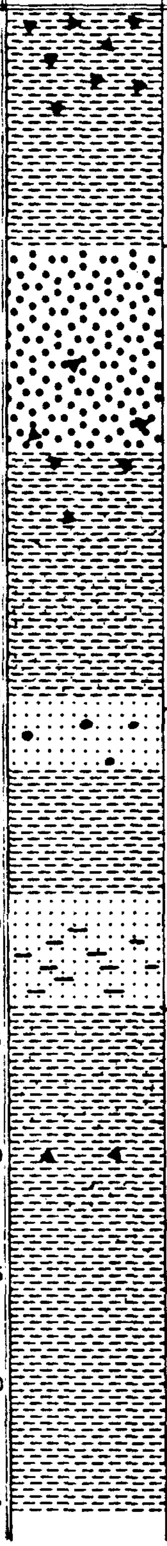
VARIAGATED CLAYS; SILICA SAND INTERBEDS: 120.0-273.0'

Thinly layered and laminated coloured clays varying from white, yellow, beige, tan, green, olive, blue-grey, grey, purple, rose, peach, red, and brown. Clays are noncalcareous, non-gritty to gritty, soft to stiff. Sequence includes several silica sand interbeds. Clays may contain minor lignite; generally restricted to upper portion of section. Clays are often very sandy with proportion of sand to clay ranging from 25 : 75 to 40 : 60.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX - 82 - 12

Sheet 3 of 6

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number
40–43	130–140				82-255
43–49	140–160			25 / 80	
49–53	160–174			C.S.	82-256
53–58	174–190		NS	C.S.	NS
58–60	190–197		NS	C.S.	NS

Description

130.5-137.0': Dark grey clay contains abundant lignite chips of up to ¼" long.

140.0-150.0': Possible silica sand interval.

150.0-160.0': Sandy clay; sand occurs in varying proportions as part of sample; from 40 : 60 to 25 : 75.

160.0-163.0': Fine- to coarse-grained silica sand interval.

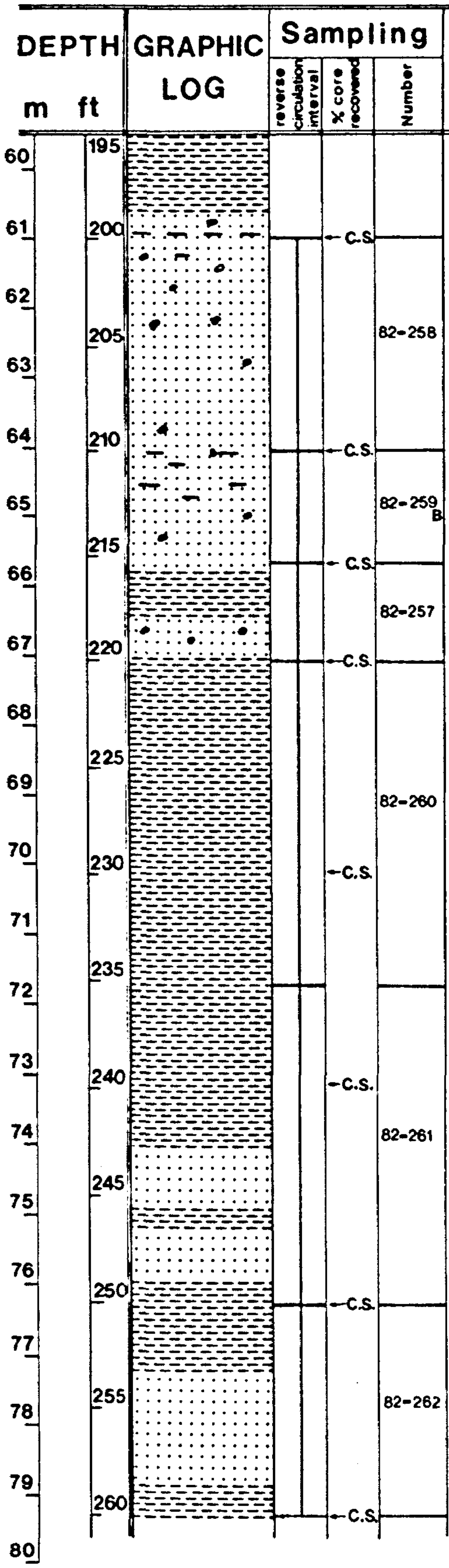
168.0-172.5': Medium- to coarse-grained white-buff coloured silica sand. Contains minor white soft very gritty clay. Sand is probably rich in kaolin as it becomes stark white at the end of the interval.

172.5-175.0': Minor sandy component.

179.0-180.0': Trace lignite.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-12



Description

199.0-216.0': Coarse- to fine-grained silica sands; sub-angular to rounded grains. White clay inter-bed occurs at 200.5 to 200.6; blue-coloured clay appears intermittently in sand from 210.0-220.0'.

218.0-220.0': Fine-grained silica sand.

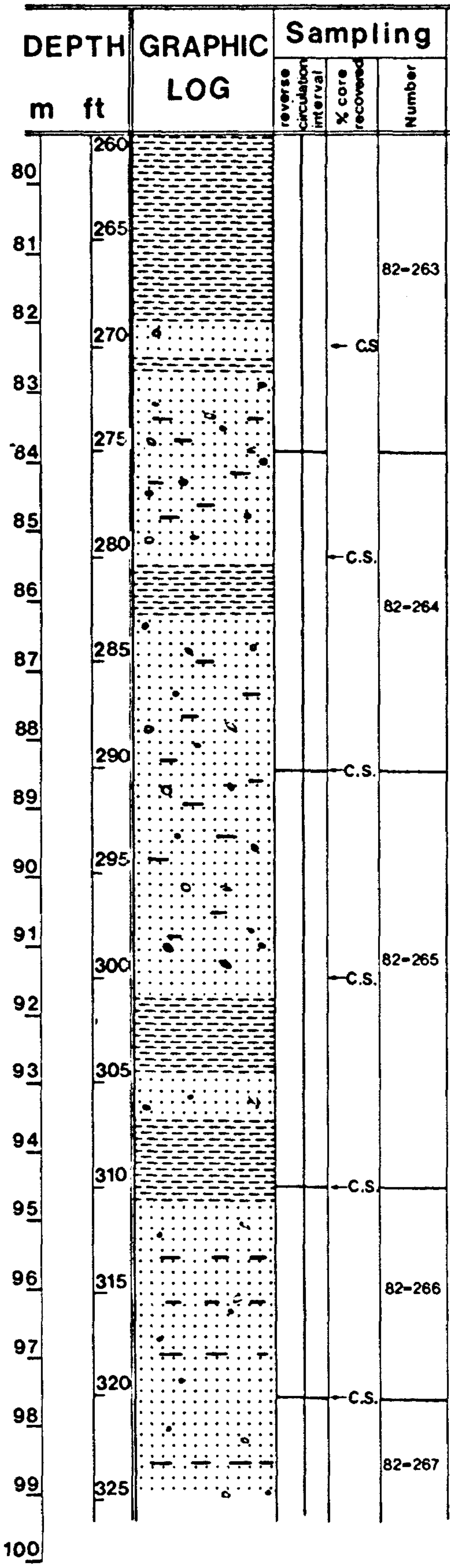
243.2-245.5': Silica sand; buff-coloured, very fine-grained; containing very fine silver-coloured flakes of muscovite; minor white clay is soft and slightly gritty.

246.5-249.0': As above, but muscovite now comprises ≈20% of sand.

254.0-260.0': Silica sand; white, fine- to medium-grained; some very gritty blue, olive green, and pale blue clay appear with sand up to 255.0'. At 258.0', white and light grey soft, very gritty clay occur with sand.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-12



Description

269.0-270.5': Silica sand; white, very fine-grained as above; issuing along with the sand are white, yellow, and rose varved clays; gritty, medium stiff.

SILICA SAND WITH MINOR CLAY INTERBEDS: 273.0-390.0'
Bimodal; very coarse-grained/granule to very fine-grained; subangular to subrounded grains, moderate sphericity; sand contains minor white gritty, soft clay. Conspicuous flakes of muscovite are evident throughout the sand. Although dominantly clear quartz, smoky quartz and white chert both occur as siliceous components. Clay interbeds are common to sequence; sand appears to be graded.

281.5-283.0': White clay interbed; very gritty, soft, and noncalcareous.

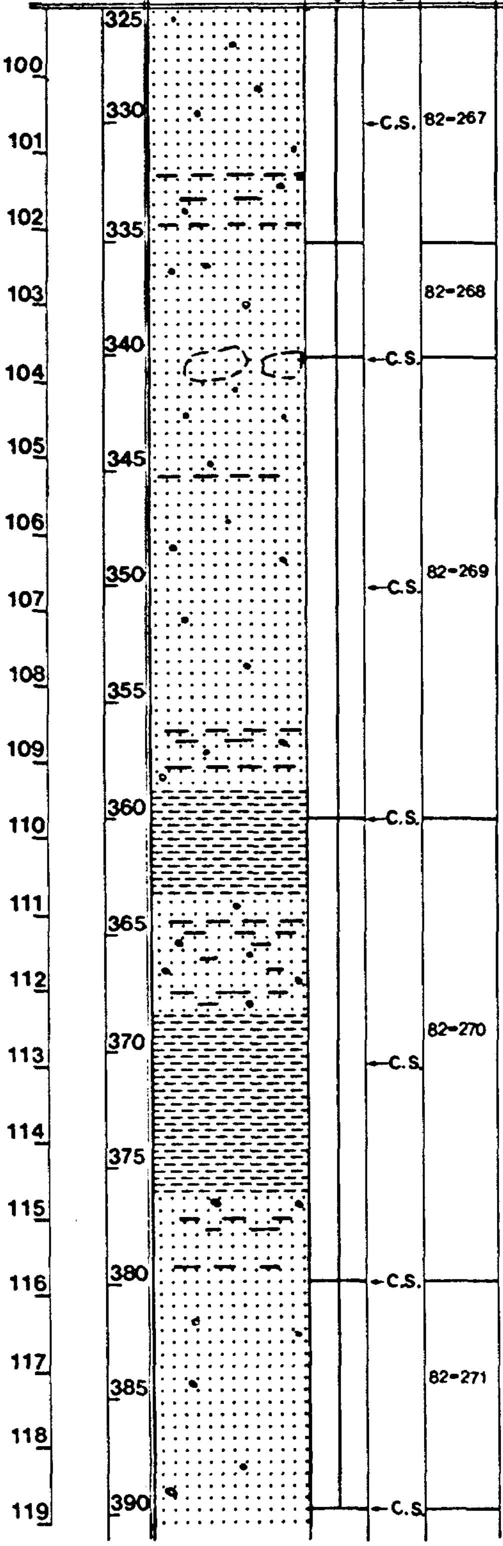
302.0-305.0': Thin layer of white clay.

307.0-311.5': Red-brown and very light grey-green mottled clays becoming red and yellow-green at 311.0'. Stiff at first then becoming soft at end of interval. Micaceous at 311.0-311.5'.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-12

DEPTH (m, ft)	GRAPHIC LOG	Sampling (reverse circulation interval, % core recovered, Number)	Description



342.0': Quartz-rich cobbles.

345.0': Minor sedimentary clasts.

359.0-364.0': Yellow and brick red clay; soft, non-gritty, noncalcareous. Becoming a medium brown at 363.0'. Contains minor quartz sand.

369.0-376.0': Light grey-white clay; soft, non-gritty, non-calcareous, with no sandy component.

385.0-390.0': Minor organic debris.

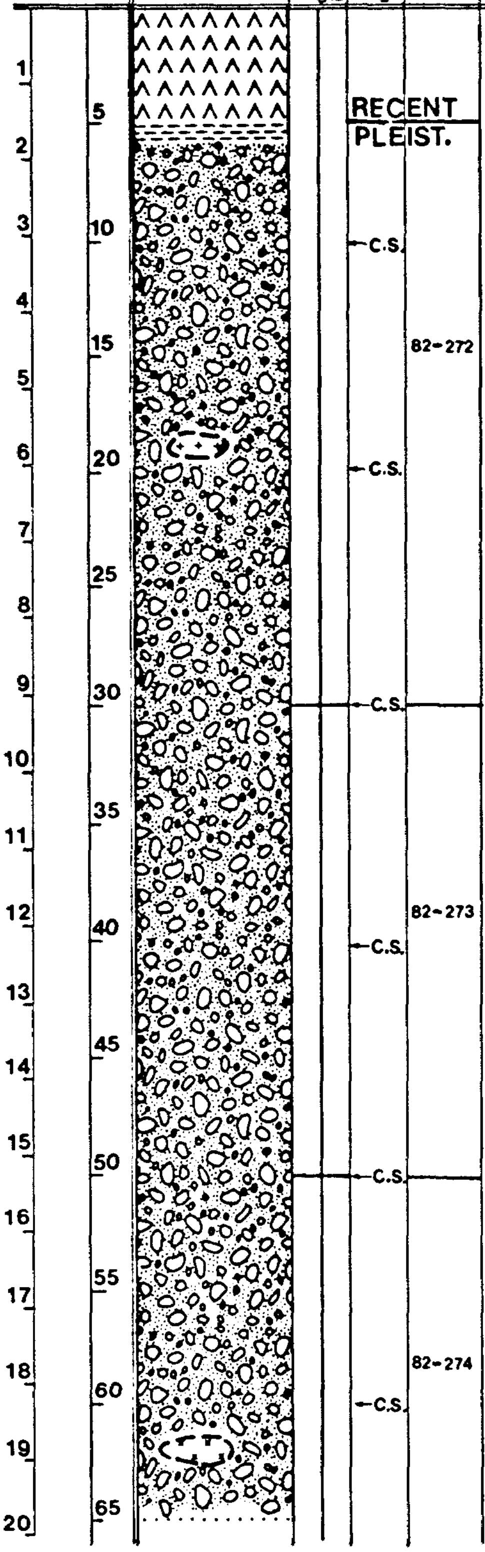
390.0': END OF HOLE

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-13 Location: CENTRAL GARDEN TWP.

Elev. of collar: 449 ft Sheet 1 of 7 (lat. 50°08'12"N long. 82°47'19"W)

DEPTH (m, ft)	GRAPHIC LOG	Sampling (reverse circulation interval, % core recovered, Number)	Description



MUSKEG: 0-5.0'

CLAY: 5.0-15.0'
Olive green-grey calcareous stiff clay; gravel includes chert, jasper, limestone, basement. Sand is fine- to medium-grained.

SANDY TILL: 15.0-41.0'
Green-grey clay is washing out. Calcareous fine- to medium-grained sand. Polymictic calcareouss pebbles; fragments composed of predominantly sedimentary rocks.
19.0-19.5': Boulder.

CLAY TILL: 41.0-65.0'
41.0-52.0': Green-grey calcareous till; moderately stiff sand; sand is fine-grained, polymictic. Clasts consist of limestone, jasper, black siltstone, chert (90%), and 10% dark basement fragments.

52.0': Very minor sand fraction.
52.0-55.0': Clay is green-grey, stiff, calcareous; minor sand fraction; fewer pebbles and clasts than 41.0-52.0'.
55.0-65.0': Clay till similar to 41.0-52.0'.

63.0': Diabase boulder ≈½' thick.

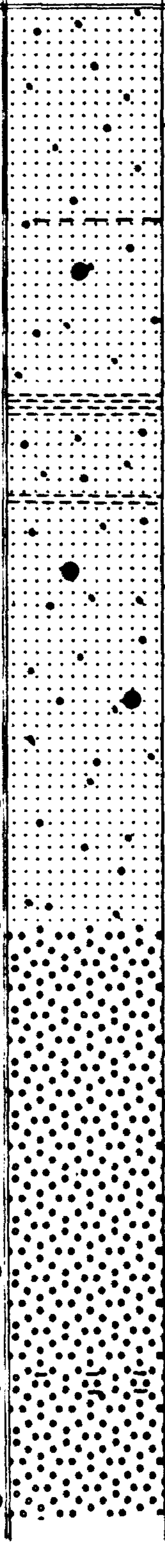
1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-13

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description

Depth (m): 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40

Depth (ft): 65, 70, 75, 80, 85, 90, 95, 100, 105, 110, 115, 120, 125, 130



Sampling: C.S. (at about 70, 81, 90, 101, 111, 121 and 131 ft)

Sample numbers: 82-274, 82-275, 82-276, 82-277

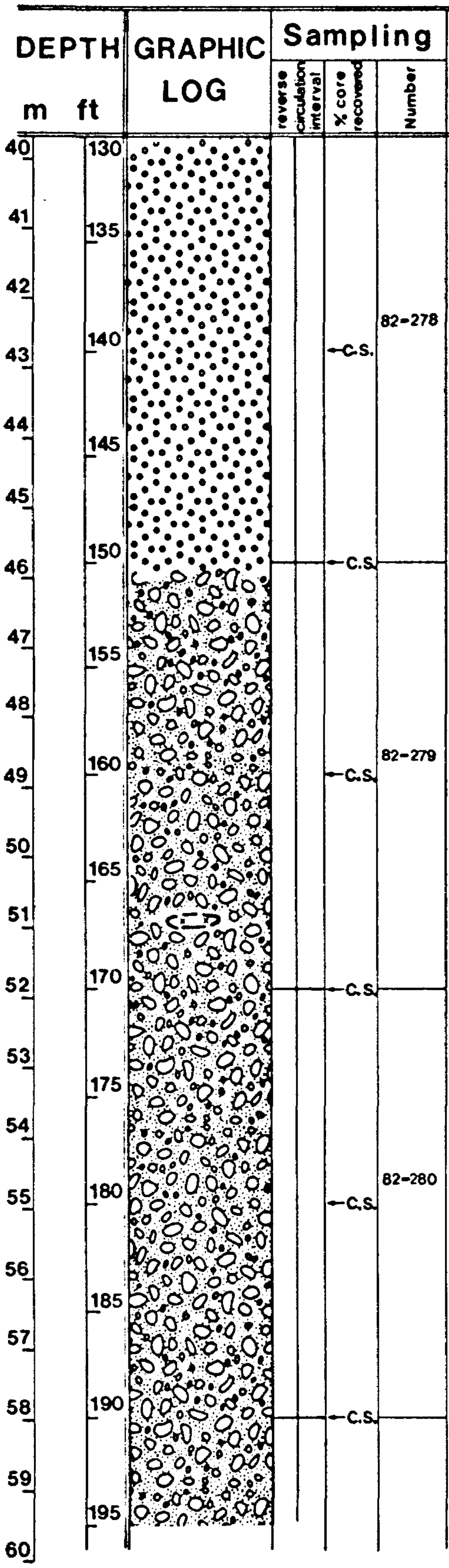
SAND AND GRAVEL: 65.0-150.0'

Light grey, predominantly fine to medium quartz sand, polymictic; fragments and pebbles are mixed; limestone white and grey chert, jasper, black siltstone, granite, diabase.

74.0':	Chert pebble; also possible red-brown clay interbed.
81.5-82.5':	Red-brown, calcareous clay, moderately stiff.
86.0-86.5':	Clay interbed as above.
105.0-125.0':	Thin graded beds up to ≈1' thick; fine- to coarse-grained sand; pebbles and cobbles included in sand/gravel. Sand is calcareous due to trace clay particles, subrounded to subangular clasts.
125.0':	More clay interbedded with sand and gravel.
125.0-150.0':	Pebbles are becoming more angular; fewer rounded pebbles as in previous interval; appears to be graded.

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-13



Description

SANDY TILL: 150.0-160.0'
Becoming more like a sandy till due to increased clay content.

CLAY PEBBLE TILL: 160.0-233.0'
Increase in clay; minor sand fraction, fine polymictic predominantly angular clasts of beige limestone, white and grey chert, jasper, granite; diabase.

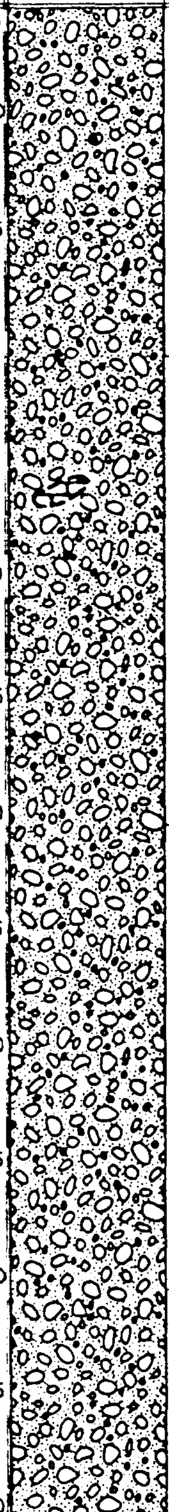
167.5': Diabase boulder.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-13

DEPTH m	DEPTH ft	Sampling: % core recovered	Sampling: Number
60	195		
61	200	C.S.	
62			82-281
63	205		
64	210	C.S.	
65			
66	215		
67	220	C.S.	82-282
68			
69	225		
70	230	C.S.	
71			
72	235		
73	240	C.S.	82-283
74			
75	245		
76			
77	250	C.S.	
78	255		82-284
79	260	C.S.	
80			

GRAPHIC LOG



Description

200.0': 70% sedimentary clasts; limestone, chert, siltstone, jasper; 30% basement – granite and diabase.

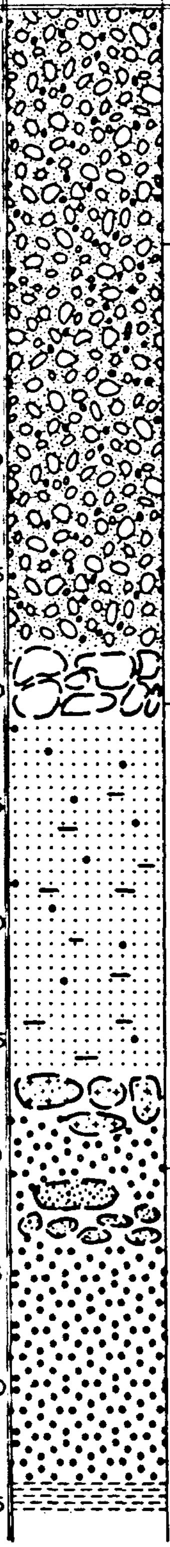
216.0': Boulder – ≈½' limestone.

CLAY TILL: 233.0-266.0'

Predominantly green-grey moderately stiff clay; clay is calcareous with pebble fragments of sedimentary clasts (60%) – beige limestone, white chert, and black siltstone; basement clasts (40%) – diabase and granite.

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-13

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
80–100	260–325			C.S. (270, 280, 290, 300, 310, 321)	82-284, 82-285, 82-286, 82-287	see below

SANDY PEBBLE TILL: 266.0-290.0'
Light brown, fine- to medium-grained polymictic sand; calcareous. Minor green-grey calcareous clay and usual pebble suite; clasts are rounded to angular.

287.0-290.0': Cobbles and boulders.

GRAVEL: 290.0-323.0'
Moderately to very sandy. All pebble clasts <1 cm; sedimentary clasts comprise ≈70%, basement ≈30%. Sand is polymictic and calcareous. Grey-green calcareous clay occurs in very minor amounts. Pebble suite consists of diabase, granite, limestone, chert, quartz, and jasper. Clasts are subangular to subrounded.

306.0-319.0': Cobbles or boulders; basement and sedimentary in composition.

312.0': Boulder.
313.0-314.0': Cobbles (sedimentary).

316.0': Trace brown wood fibre.
319.0-323.0': Pebbles generally subrounded and more abundant.

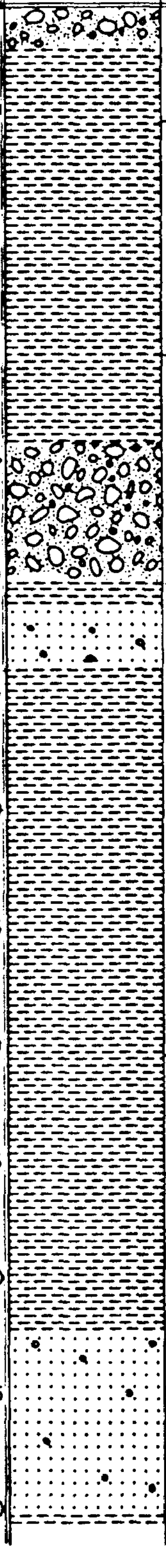
CLAY: 323.0-324.0'
Moderately dark grey clay; calcareous, gritty, moderately stiff with minor very fine-grained sand.

TILL: 324.0-325.0'
Clay matrix as above with sedimentary and basement clasts.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-13

Sheet 6 of 7

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
	325				82-288	CLAY: 326.0-342.0' Medium dark grey clay; calcareous, soft to very stiff by 327.0'; non-gritty, minor to moderate amounts of fine-grained sand.
100	330			C.S.		
101						
102	335		NS		NS	
103	340			C.S.		
104						CLAY TILL: 342.0-349.5' As 325.0-326.0'.
105	345				82-289	
106						CLAY: 349.5-350.5' Clay similar to 326.0-342.0 with minor grit and minor sand.
107	350			PLEIST. / CRETAC.		SAND: 350.5-352.0' Light grey fine to coarse quartz sand; subangular to subrounded with interbeds of medium grey clay.
108	355					CLAY: 352.0-381.0' Thinly layered various coloured clays ranging from white, green-grey, olive green, orange, brown, and dark grey. Clays are stiff, slightly gritty to gritty with minor clasts of limestone and quartz in places. Becoming noncalcareous by 367.0'. 354.0': Minor wood chips.
109						
110	360		NS	C.S.	NS	
111	365					
112						
113	370			C.S.		
114					82-290	
115	375			C.S.		
116	380			80		
117						SAND: 381.0-390.0' Possible sand seam implied by missing interval.
118	385			22		VARIEGATED CLAYS: 390.0-400.0' Thinly layered and laminated brightly coloured clays ranging from white, tan, yellow, orange, red, green, beige, and grey. Clays are soft, noncalcareous, and gritty. Minor quartz sand seams are included in interval.
119	390					

Drill Hole Nº: ONEX-82-13

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
119	390					392.0-393.0': Quartz sand.
120	395				82-291	
121						398.0-399.5': Quartz sand.
122	400					400.0': END OF HOLE
123	405					
124						
125	410					
126	415					
127						
128	420					
129	425					
130						
131	430					
132	435					
133						
134	440					
135	445					
136						
137	450					
138	455					
139						

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-14 Location: SE McBRIEN TWP.

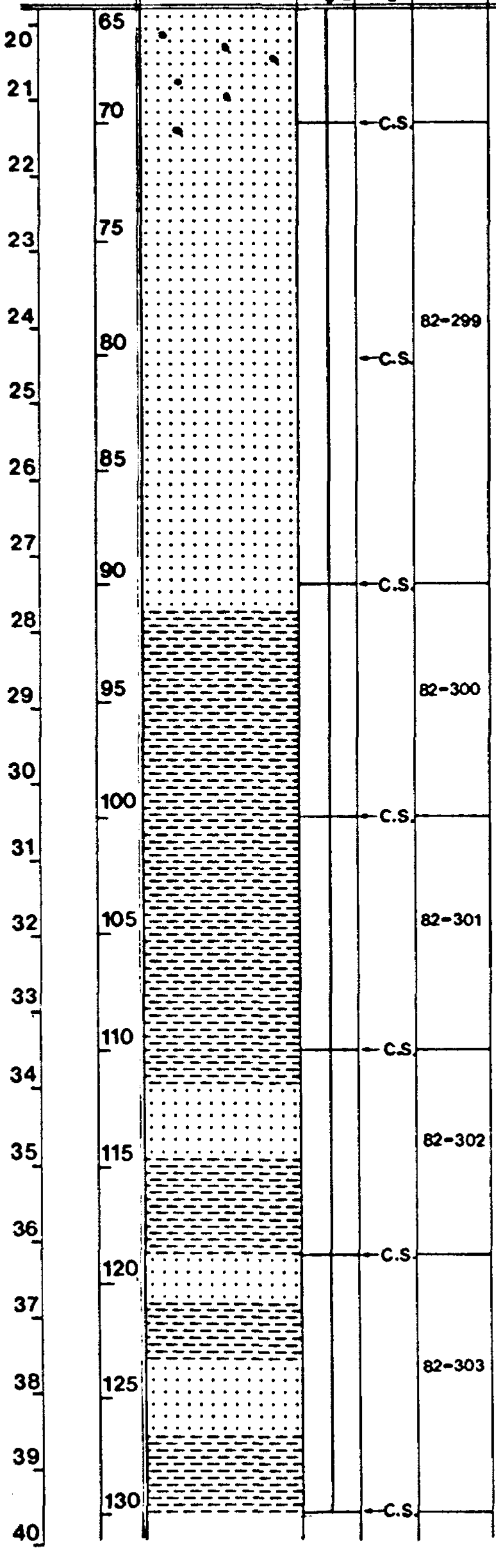
Elev. of collar: Sheet 1 of 10 (lat. 50°08'12"N long. 82°56'49"W)

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
1				C.S.		MUSKEG: 0-3.0' — RECENT / PLEIST.
						SANDY TILL: 3.0-49.0' Medium grey, pebbly. Very heterolithic clasts of basement and Paleozoic material. By 20.0' much more sandy and clayey. Fewer pebbles. Still have narrow intersections of more pebble-rich till.
2	5					
3	10					
4						
5	15				82-296	
6	20			C.S.		
7						
8	25					
9	30			C.S.		
10						
11	35					35.0': Diabase boulder.
12					82-297	
13	40			C.S.		
14	45					
15				PLEIST. / CRETAC.		
16	50					QUARTZ SAND: 49.0-91.0' Quite variable in size. Immature. Moderate amounts of kaolin. No significant mica.
17	55					
18	60				82-298	
19						
20	65					

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-14

DEPTH (m, ft)	GRAPHIC LOG	Sampling (reverse circulation interval, % core recovered, Number)	Description



71.0': Quartz sand predominantly fine-grained.

VARIEGATED CLAYS: 91.0-124.0'

- 91.0-92.0': White and light tan clay.
- 92.0-92.5': White clay; soft, noncalcareous.
- 92.5-100.5': Tan clay with interbeds(?) of reddish clay. Red clays softer than tan clays. At 95.0' ≈2" quartz sand bed.
- 100.5-101.0': Light grey to white clay.
- 101.0-112.0': Light grey clay with occasional brick red intervals.
- 112.0-114.0': Quartz sand.
- 114.0-119.0': Reddish-brown and tan clay with several 5-6" white clay interbeds.
- 119.0-120.0': Quartz sand.
- 120.0-124.0': Similar to 114.0-119.0'.

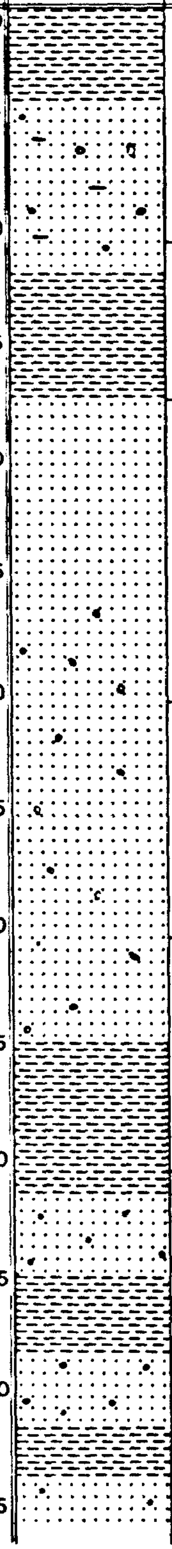
SAND: 124.0-126.0'

Quartz sand with minor fine-grained muscovite.

CLAY: 126.0-130.0'

Light grey clay-silt, gritty. Some tan clay.

Drill Hole Nº: ONEX-82-14

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
40–60	130–195			C.S. (at 141, 149, 161, 171, 181, 190 ft)	82-304, 82-305, 82-306, 82-307, 82-308, 82-309	see below

SILICA SANDS AND CLAY: 130.0-174.0'

130.0-134.0':	White clay — soft, noncalcareous, gritty with interlayers of fine silica sand. Minor amounts.
134.0-141.0':	Fine–coarse silica sand with minor white clay.
141.0-142.0':	White clay; soft, gritty.
142.0-145.0':	Yellow-brown (tan) clay; stiff, non-gritty, noncalcareous. At 144.0' is 2" layer white, noncalcareous, non-gritty clay.
145.0-147.0':	White, soft, noncalcareous clay. Minor grit.
147.0-174.0':	Fine to coarse silica sand. Minor coarse particles with moderate amount of mica. Sand is subangular to subrounded. At 154.0' is 2" layer of white clay.

CLAY: 174.0-176.0'
Tan clay, soft, non-gritty, noncalcareous.

CLAY: 176.0-179.0'
White clay, soft, noncalcareous. Minor sand from 177.0-177.5'.

CLAY: 179.0-180.0'
Deep rust with white layers. Soft, noncalcareous, non-gritty. Varved?

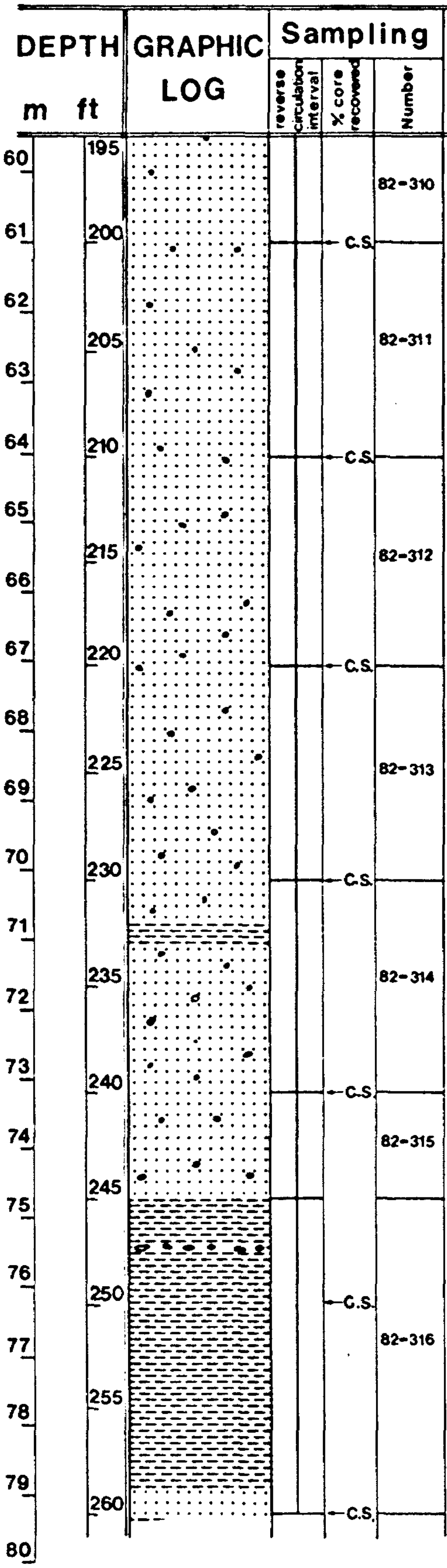
SILICA SANDS AND CLAY: 180.0-245.0'

180.0-181.0':	White clay, soft, non-gritty, noncalcareous.
181.0-184.0':	Fine to coarse silica sands. Grains are subangular to subrounded. Minor amount of muscovite.
184.0-185.0':	White clay, soft, moderate amount of silica sand.
185.0-188.0':	Tan clay, soft, minor clay, noncalcareous. At 186.0' rust coloured, mottled.
188.0-245.0':	Silica sand. Fine- to coarse-grained, subangular to rounded. Muscovite occurs in fine sands.
190.5-193.0':	Whitish-grey clay, soft, noncalcareous with minor fine sand.

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole No: ONEX-82-14

Sheet 4 of 10



Description

232.0-233.0': Same as 190.5-193.0'.
233.0-236.0': Very fine-grained silica sand with abundant fine muscovite.

CLAY: 245.0-246.0'
Light brown clay. Moderately stiff, noncalcareous, slight grit.

CLAY: 246.0-247.0'
Tan clay. Moderately stiff, noncalcareous, gritty.

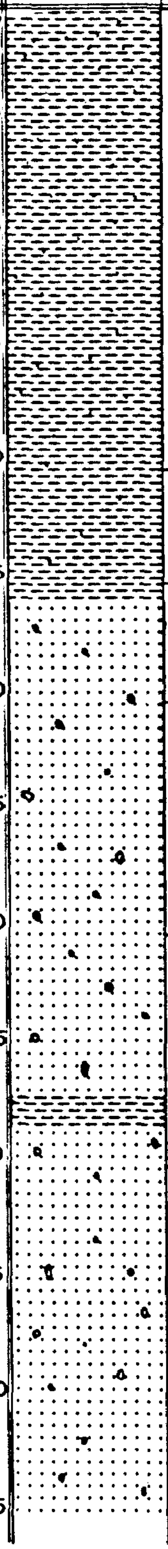
SAND: 247.0-247.5'
Coarse silica sand.

CLAY: 247.5-257.0'
Brick red clay with yellow mottling, soft, noncalcareous, non-gritty. By 251.0' becomes harder with moderate grit (quartz grains). By 253.0' becomes very gritty. By 254.0' back to soft brick-red clay. Slight grit with occasional interbeds of light grey clay.

CLAY AND SAND: 257.0-260.0'
At 257.0' sample is dominantly a light grey clay. From 258.0-258.5' is a fine-grained quartz sand with fine-grained mica. At 258.5-260.0' once again a light grey soft clay with minor fine-grained quartz sand.

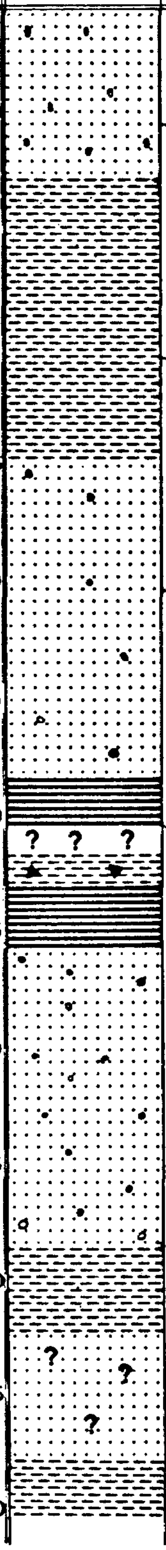
1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-14

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
	260					VARIEGATED CLAY SEQUENCE: 260.0-284.0' Thinly layered and laminated coloured clays varying from white, yellow, tan, rust, and light and dark grey. Clays are noncalcareous, soft to medium stiff, non-gritty to gritty. Sequence includes minor amounts of sand.
80						
81	265					
82	270			C.S.	82-317	
83						
84	275					
85	280			C.S.		
86					82-318	
87	285				82-319	SILICA SAND: 286.0-358.0' Fine- to coarse-grained silica sand; subangular to subrounded grains; contains muscovite. Contains minor clay interbeds.
88	290			C.S.		
89						
90	295				82-320	
91	300			C.S.		
92						
93	305				82-321	
94						307.0-308.5': Light grey-white, gritty, noncalcareous, soft clay. Still abundant micaceous silica sand.
95	310			C.S.		
96	315				82-322	
97	320			C.S.		
98						
99	325				82-323	
100						

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-14

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
100–119	325–390					

Depth scale (m): 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119

Depth scale (ft): 325, 330, 335, 340, 345, 350, 355, 360, 365, 370, 375, 380, 385, 390

Sampling (top to bottom): 82-323; C.S.; 82-324; C.S.; 82-325; C.S.; 82-326; C.S.; NO REC'V; 100; 0; 10; 16; 100; 45

333.0-344.0': Yellow-grey, soft, non-gritty clay; minor sand. Becoming tan in colour at 338.5', and light grey at 339.0'.

344.0-358.0': Considerable kaolin and noticeable fine-grained muscovite in silica sand; very minor FeS_2.

CLAY AND SAND SEQUENCE: 358.0-422.0'

358.0-360.0': Dark grey carbonaceous clay with quartz.

361.5-363.0': Medium to dark grey clay and lignite.

363.0-366.0': Dark grey carbonaceous clay; conspicuous quartz grains are present.

366.0-367.0': Quartz sand.

369.0-373.0': 6" recovery of quartz-clay-mica; most of the sand washed out.

373.0-379.0': Only ≃1' recovery of light grey clay with considerable quartz grains grading downward into more pure light grey clay that becomes dark grey clay at end of run.

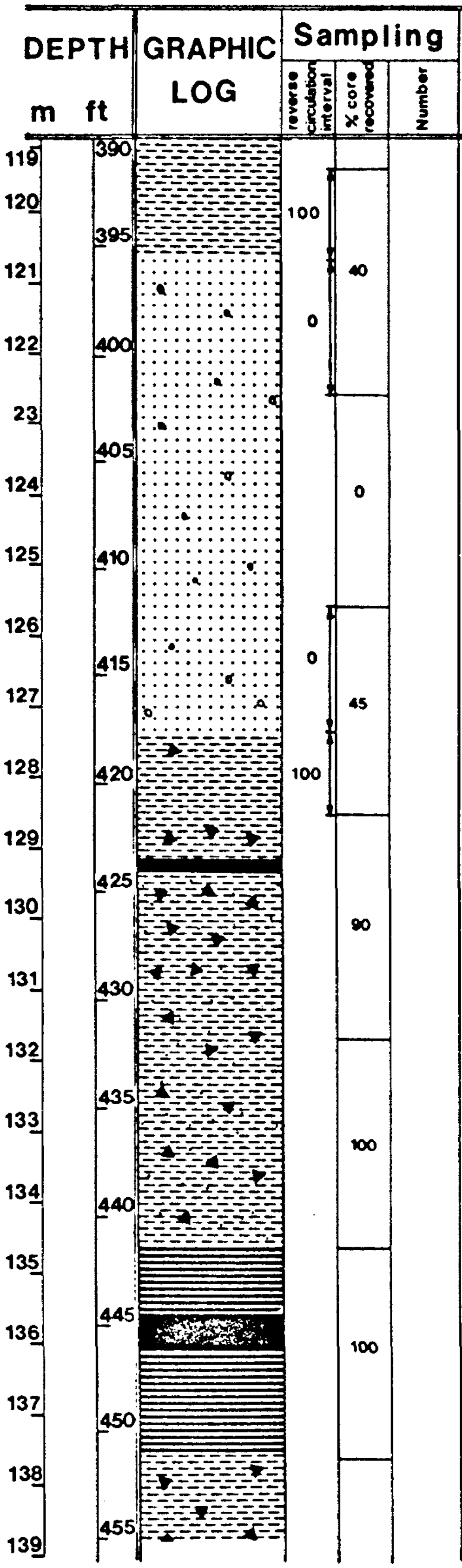
379.0-382.0': Medium to light grey clay; moderately gritty.

382.0-387.5': Possible sand seam.

387.5-392.0': Medium grey clay with thin (½") lignite seam at 387.7'.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-14



Description

392.0-396.0': Medium grey clay becoming a light yellow-grey with yellow mottles at end of interval.

396.0-417.5': Extremely poor recovery over this interval suggests the occurrence of a sand seam.

417.5-422.0': Medium to light grey clay — very gritty, noncalcareous with minor lignite chips. May contain mica as is indicated by soapy texture. At 420.5' core becomes very hard due to abundance of quartz grains.

CLAY AND LIGNITE SEQUENCE: 422.0-442.3'

422.0-424.0': Dark grey clay; only slightly gritty with abundant lignite and very minor mica.

424.0-424.5': Lignite — dark grey-black with minor dark brown woody sections.

424.5-426.7': Dark brown-grey clay with lignite.

426.7-442.3': Medium grey soft clay with considerable lignite and abundant fine-grained muscovite. Tan mottling occurs until 435.2'. Very sandy in sections.

436.0-436.5': Interval of dark grey clay with considerable lignite.

CARBONACEOUS CLAY WITH LIGNITE: 442.3-452.0'

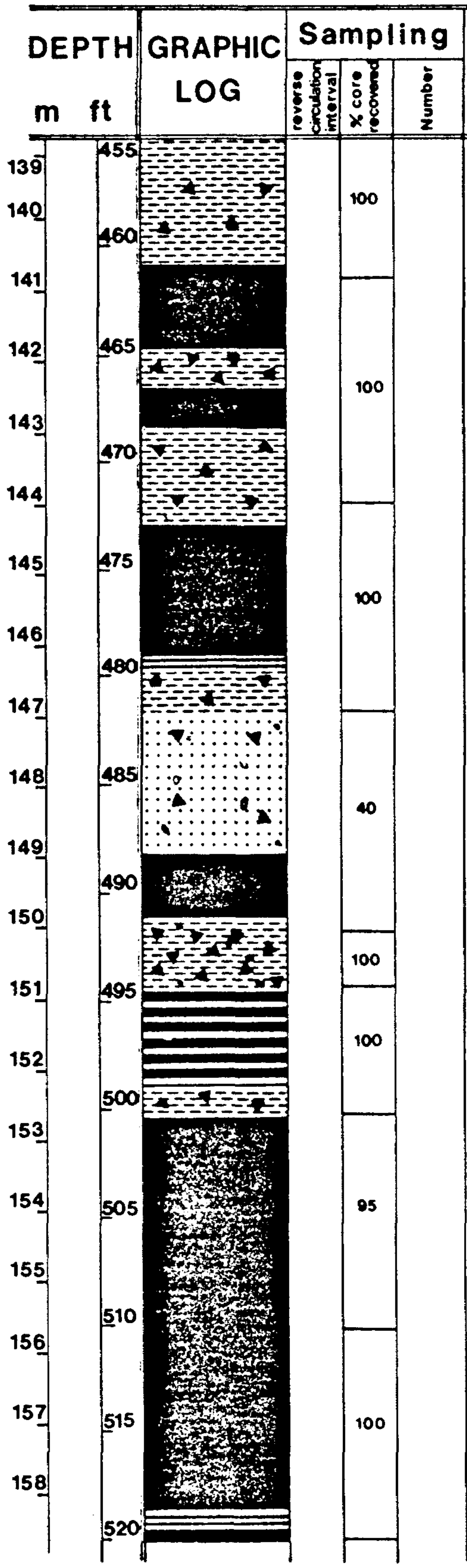
442.3-452.0': Dark grey to black carbonaceous clay with a lignite seam from 445.0 to 446.5'.

CLAY: 452.0-461.7'

Largely medium to dark grey clay containing abundant lignite debris. Bedding is often on the 1-4" scale, but in some cases up to ≈12". Occasional gritty immature sandstone (quartz) lens (<2"). Lignite very spotty but persistant.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-14



Description

LIGNITE: 461.7-465.2'
Mostly fragmental lignite with considerable amounts of clay and quartz grains; minor but noticeable FeS_2; also elemental sulphur.

CLAY: 465.2-467.2'
Grey clay with considerable coarse lignite.

LIGNITE: 467.2-469.0'
Same as above.

CLAY: 469.0-473.3'
Clay with considerable lignite (coarse).

LIGNITE: 473.3-480.0'
Much the same as above except contains considerably more clay in thin bands and intermixed. A few coarse blebs or lenses and some fine-grained disseminated FeS_2. Grades down into grey carbonaceous clay.

CLAY AND SAND: 480.0-488.5'
Considerable lignite; missing the last 6.0'.

LIGNITE: 488.5-492.0'
As above.

CLAY: 492.0-495.0'
Medium and dark grey clay with abundant lignite chips; very gritty.

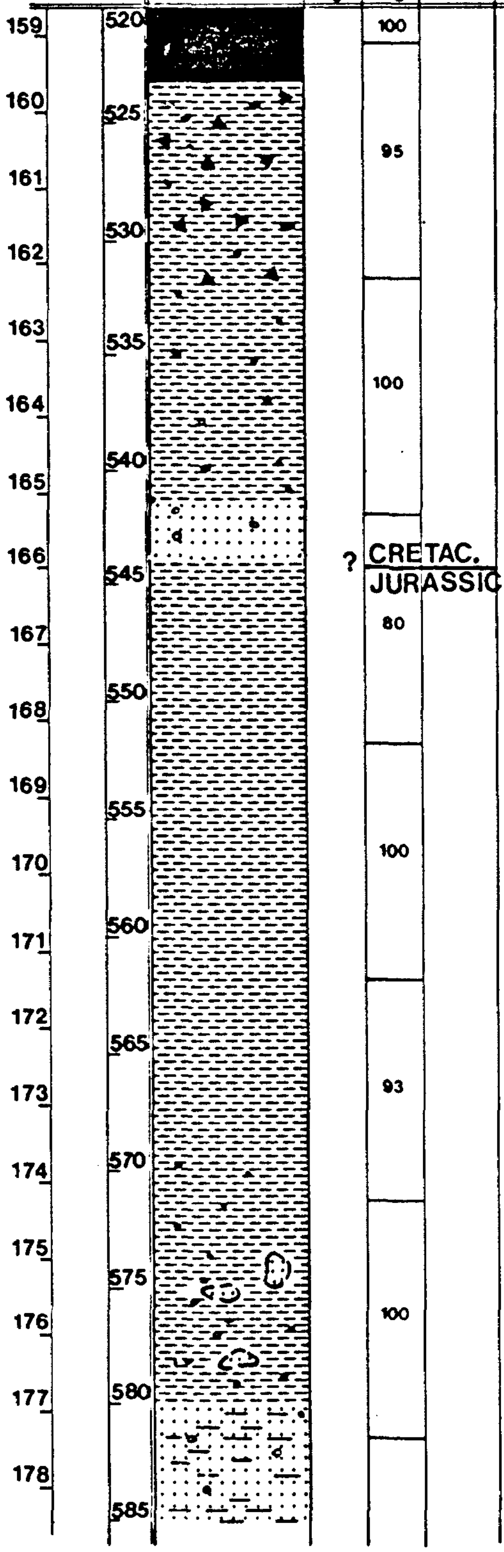
LIGNITE AND CLAY: 495.0-500.0'
Lignite with abundant clay; probably a carbonaceous clay.

CLAY: 500.0-501.0'
Medium grey clay with considerable lignite.

LIGNITE: 501.0-524.0'
Lignite with considerable clay; from 519.0-520.0' mostly medium to dark clay. At 524.0' gradational into dark grey massive clay. The lignite section is quite variable; some narrow lenses of distinctly brown lignite, but most is dark grey to black. Much of it is fragmental; a few light yellow-beige specks that may be elemental sulphur. Overall this section is not very high grade lignite because of the fairly abundant clay present; very minor FeS_2.

Drill Hole Nº: ONEX-82-14

DEPTH (m, ft)	GRAPHIC LOG	Sampling (reverse circulation interval / % core recovered / Number)	Description



CLAY AND SAND: 524.0-544.5'

524.0-533.0': Medium grey clay with abundant small lignite chips and quartz grains.

533.0-542.0': Clay becoming lighter grey colour and increasingly gritty (quartz); minor lignite.

542.0-544.5': Possibly a sandy interval.

CLAY: 544.5-571.0'

544.5-546.5': Light chocolate brown-clay.

546.5-552.0': Light to medium grey clay.

552.0-557.0': Light grey clay (noncalcareous).

557.0-561.5': Medium grey clay.

561.5-562.0': Chocolate brown clay.

562.0-571.0': Light chocolate brown clay with distinct deep rust-coloured mottling.

CLAY AND SAND SEQUENCE: 571.0-592.0'

571.0-575.0': Light grey noncalcareous clay with abundant sand grains (a lot of quartz) grading downward into a very immature sandstone at 574.5 to 575.0'; fairly abrupt change to clay.

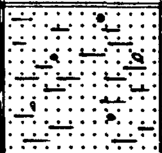
575.0-581.8': Largely medium brown clay with numerous sand clasts; some clasts appear to be fairly coarse lithics (sedimentary with microfossils).

581.8-592.0': Fairly abrupt change into clay-rich sandy sediments; immature; abundant quartz; very minor lignite chips; all of sediments from 571.0-592.0' are noncalcareous.

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-14

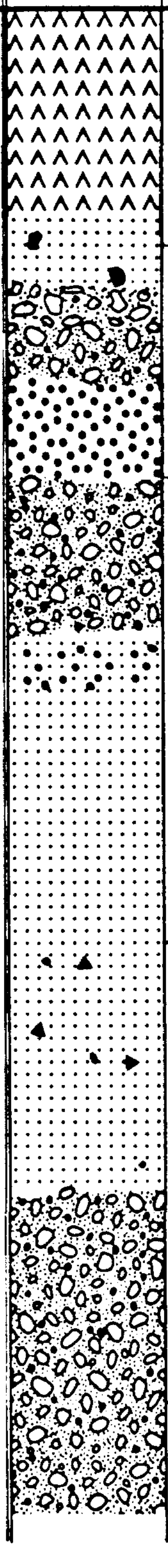
Sheet 10 of 10

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
	585					
179				18		
180	590					
						592.0': END OF HOLE.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

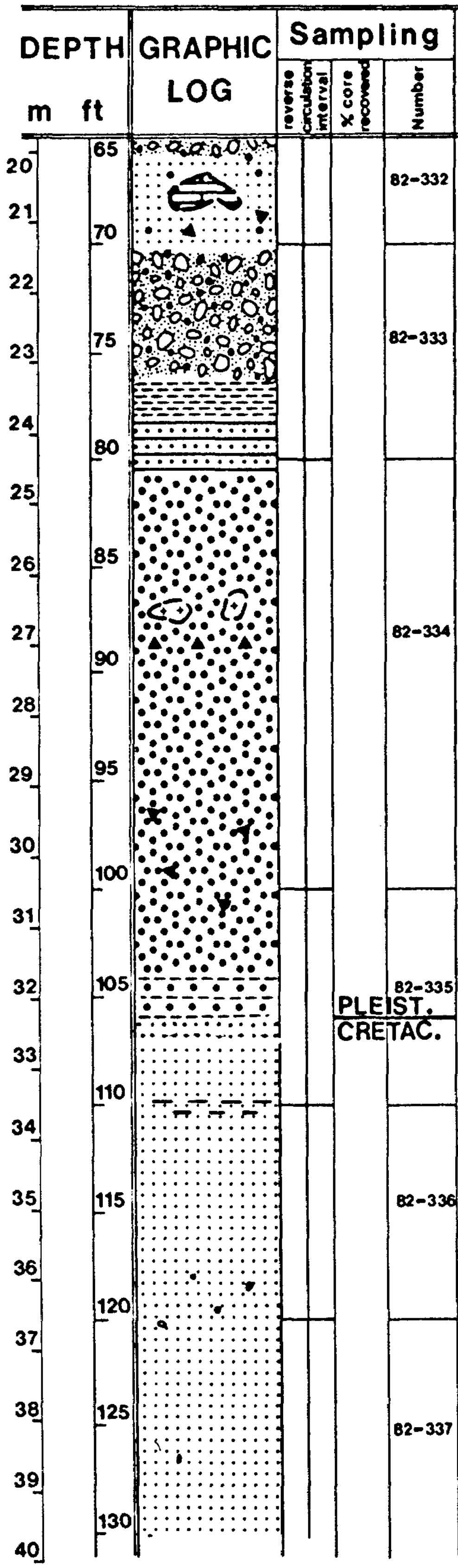
Drill Hole Nº: ONEX-82-15 Location: WEST-CENTRAL HAMBLY TWP.

Elev. of collar: 410 ft Sheet 1 of 7 (lat. 50°18'07"N long. 82°39'38"W)

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
1	5					MUSKEG: 0-8.0'
2–3	10					SAND: 8.0-12.0' Polymictic with shell fragments.
4	15			RECENT PLEIST.	82-329	CLAY TILL: 12.0-16.0' Medium stiff, medium grey clay, 100% sedimentary clasts; pebble size.
5–6	20					SAND/GRAVEL WITH SANDY TILL: 16.0-70.5' 16.0-18.0': Sandy gravel. 18.0-20.0': Sand polymictic. 20.0-26.0': Sandy till; mostly basement clasts.
7–8	25					26.0-30.0': Quartz sandy gravel with lignite.
9–11	30, 35				82-330	30.0-50.0': Fine sand alternating with coarser quartz gravel.
12–14	40, 45					40.0-46.0': Trace lignite.
15–20	50, 55, 60, 65				82-331	50.0-61.0': Sandy clay till with mixed cobble-size clasts; subangular-round granite, diabase, and sedimentary clasts. 50.0': Sedimentary boulder - limestone. 54.0': Granite boulder. 57.0': Diabase boulder. 58.0': Increasing sedimentary fragments. 61.0-61.5': Silica sands. 61.5-63.0': Sandy clay till with trace organic matter. 63.0-70.5': Sand and gravel; medium-grained polymictic in fine sandy matrix. 65.0': Trace lignite.

1982 DRILLING PROGRAM-JAMES BAY LOWLA

Drill Hole Nº: ONEX-82-15



Description

67.0': Limestone boulder.
69.0': Trace lignite.
70.0': Chert pieces.

CLAY TILL: 70.5-80.0'

70.5-75.0': Clay till; medium grey, medium s calcareous.
71.0': Mafic boulder.
73.0': 1' layer of gravel/fine sandy matrix terval from 63.0-70.5'.
74.0': Clay becomes mixed with fine sand.
75.0-77.0': Clay; light grey-green clay, calcareo
77.0-80.0': Clay with sandy gravel; clay as above
77.5': 50/50 sand/clay matrix with small cl
78.0': Clay disappears; fine sand with grave
78.5': Clay reappears as 50/50 with very fi
79.0': Increasing clay content.

SANDY GRAVEL TILL: 80.0-89.0'

Sand, subangular clasts; mixed basement/sediment.
86.0': Larger cobbles.
87.0': Finer quartz sand with some pebbles.
88.5': 50% lignite fragments.

SANDY GRAVEL: 89.0-103.0'

Polymictic at first with quartz sand increasing 60%.
96.0': Trace lignite.
97.0': Trace lignite.
98.0': Finer sand, less gravel.
99.0': Coarse-grained quartz sand; lignite 10% of return.
99.5': Trace lignite.
100.5': Trace lignite ≈5% of return.

CLAY AND SANDY GRAVEL: 103.0-106.0'

Clay green-grey, fairly stiff.
103.5': Trace lignite.
104.0': Sandy gravel, trace clay.

SILICA SANDS: 106.0-147.0'

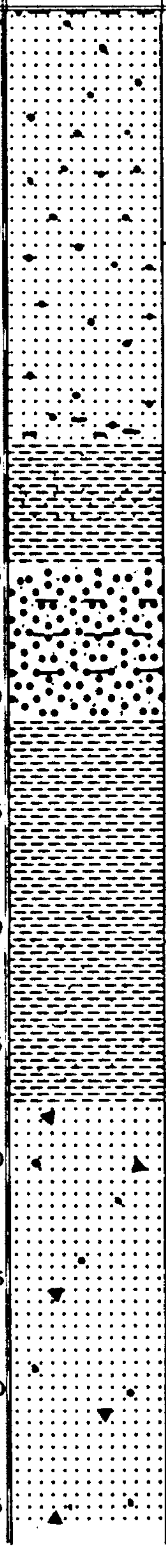
Minor amounts of grey-white clay (kaolin?).
109.0': Increasing clay ≈20%.
116.0': Decreasing clay.
119.0': Sands coarser.
120.0': Sands fine.

129.5': Clay with coarser sands.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-15

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number
40	130				
41	135				82-337
42					
43	140			C.S.	
44	145				82-338
45					
46	150			C.S.	
47	155				
48					
49	160			C.S.	82-339
50	165				
51					
52	170			C.S.	
53	175				82-340
54					
55	180			C.S.	
56	185				
57					82-341
58	190				
59	195				
60					



Description

130.5': Fine- to medium-grained silica sands.

145.0': Fine sand with visible mica.

CLAYS (NONCALCAREOUS): 147.0-177.0'

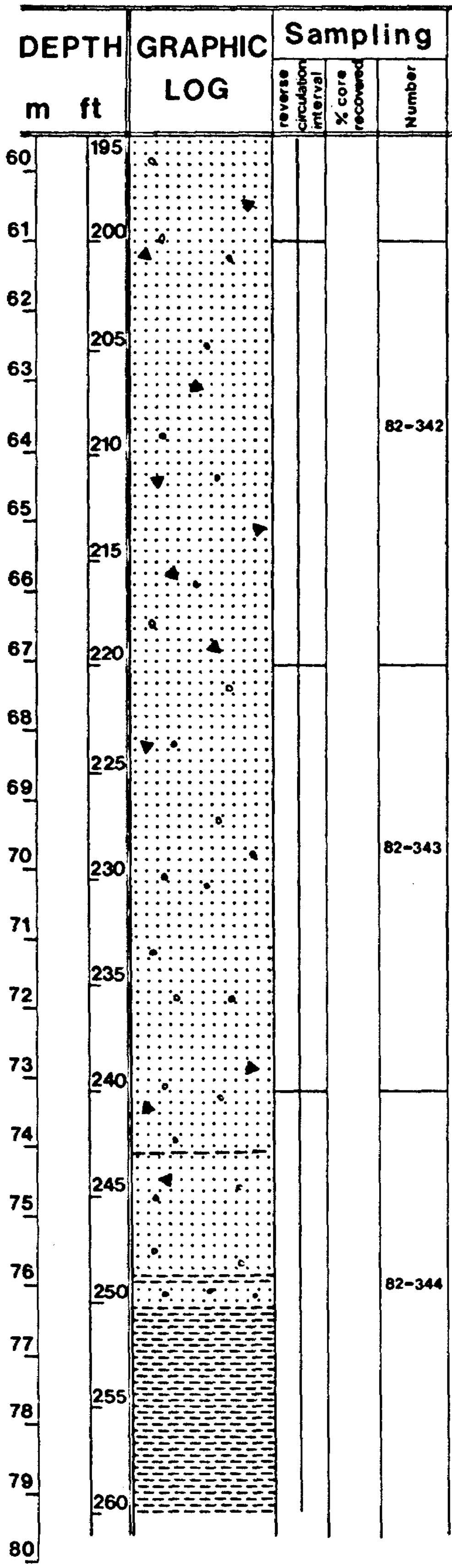
- 147.0': Light grey/white clay with very minor fine-grained sands.
- 148.0': Light green medium stiff clays.
- 148.5': Beige medium stiff with ≈5% sand.
- 150.0': Alternating light beige, soft clays, and stiff to medium stiff, light green clays with minor sand bands 3-18" thick.
- 154.0-160.0': Coarse and finer quartz sand; minor clay interbeds grading down into finer sands; repeating sequence.
- 160.0-162.5': Light grey and beige clay.
- 162.5-167.0': Light tan clay.
- 167.0-168.0': Light grey clay and very fine-grained quartz sand.
- 168.0-177.0': Dirty brown clay with minor fine-grained quartz sand.

SILICA SAND: 177.0-250.0'

Fine-grained quartz sand, minor kaolin and very minor muscovite, occasional impurities of lithic clasts; rare lignite chips; interbedded coarse and finer sands.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-15



Description

242.0':	Thin light grey clay bed (≈3").
249.0':	6" of light grey gritty clay.

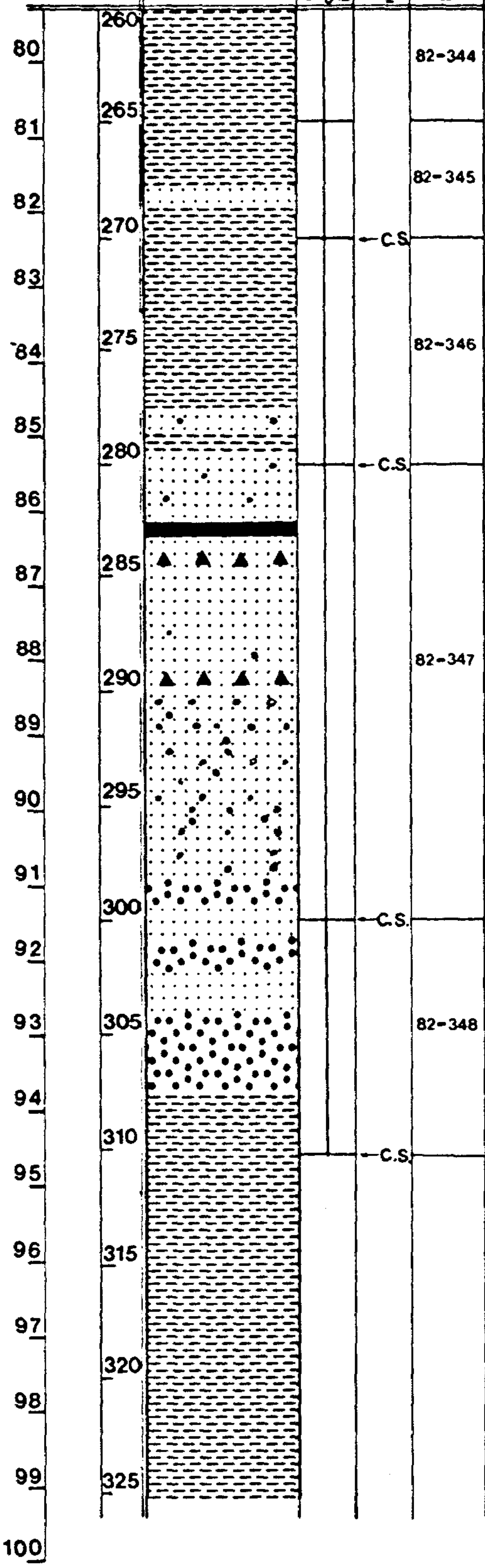
CLAY SEQUENCE: 250.0-277.5'

250.0-252.5':	Light grey clay; by 252.5' the clay is orange-brown (medium light), but becoming more of a brick-red colour by 253.0'.
260.5':	Clay becomes a red-brown, chocolate colour.

Drill Hole Nº: ONEX-82-15

Sheet 5 of 7

DEPTH (m, ft)	GRAPHIC LOG	Sampling (reverse circulation interval, % core recovered, Number)	Description



264.0': Clay becoming stiffer.
266.0': Light grey clay.
266.3': Medium grey clay; really light blue-grey clay, medium stiff.
267.0': Clay becomes softer.
268.0': Fine sand with angular mafic pieces.
268.3': Light grey clay as at 266.3'.
268.5': Extremely fine micaceous sands; mica ≈15%.
269.0': Light grey clay quickly changing to beige/tan stiff clay.
270.0': Dark grey stiff clay.
271.0': Beige stiff clay.
273.0': Dark pink-beige stiff clay.
274.0': Medium grey stiff clay becoming softer at 274.5'; stiff about 275.0', soft again at 276.5'.

FINE SILICA SAND WITH LIGNITE: 277.5-290.0'

Some mica.
279.5': Sand as above; medium dark grey soft clay.
280.0': Dark grey stiff clays/fine silica sand/wood chips/trace lignite; clay has about 10% sand content.
281.0': Sand becoming coarser.
283.0': Large lignite chips comprising >50% of sample.
283.5': Lignite no longer present.
285.0': Sand and lignite.
286.0': Trace lignite ≈5%.
287.0': Fine micaceous sand; mica ≈15%.
288.0': Trace lignite.

SILICA SANDS: 290.0-307.0'

Coarse-, medium-, and fine-grained with basement fragments. Conglomeratic sand; angular to subangular. At 300.0' becomes predominantly medium- to coarse-grained with minor mica; appears to be cyclic bedding.

CLAYS: 307.0-437.0'

307.0': Medium grey clay.
307.3': Pale green clay.
307.5': Beige/tan soft clay.
307.8': Pale green clay.
Alternating thin bands beige, green, and light grey; soft to moderately stiff clays to 309.0'.
309.0': Darker grey soft clay.
310.0': Minor fine sand with clay as above.
312.0-317.0': Largely light grey soft noncalcareous clay; minor very fine-grained.
317.0-318.5': Dark grey, soft clay, but becoming light or medium grey by 318.5'.

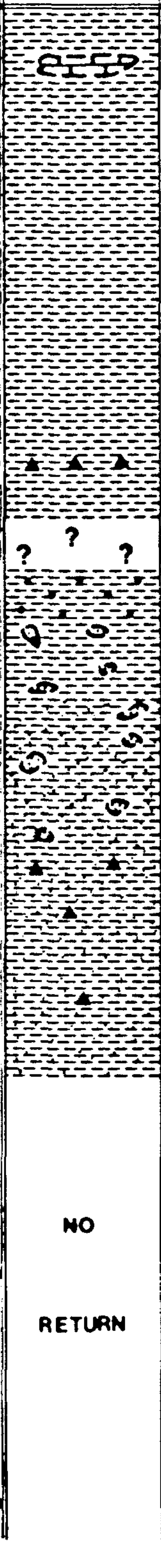
1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-15

Sheet 6 of 7

DEPTH: m 100–119; ft 325–390

GRAPHIC LOG



Sampling (reverse circulation interval / % core recovered / Number):

reverse circulation interval	% core recovered	Number
NS		NS
	12.5	
	0	
	30	
	~2	
	100	
	0	
	0	

Description

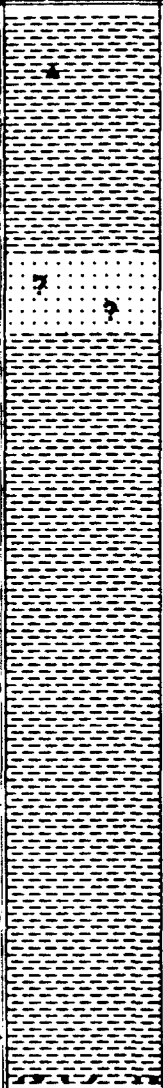
328.0':	Small limestone (green-brown, fine-grained) boulder in the grey clay and thereafter the grey clay appears to contain a fair amount of grit.
332.0':	Clays become medium grey and remain so until 340.0'.
340.0-348.0':	Medium grey, soft to medium stiff, noncalcareous, slightly gritty clay appears to contain amounts of muscovite and very minor lignite chips.
350.0-353.0':	Medium to light grey, moderately stiff noncalcareous, slightly gritty pebble clay; contains large pebble clasts of very fine-grained pyrite.
353.0-362.0':	Sandstone clasts within a clay matrix — sandstone conglomerate. Clay is light grey, very gritty (texture imparted by quartz sand), noncalcareous, soft. Sandstone is medium to light grey, fine- to medium-grained; very well indurated, dominantly quartz; percent matrix and cement unknown.
362.0-372.0':	Medium brown-grey, soft to moderately stiff, gritty to sandy clay, noncalcareous. Contains ≃15% flecks of muscovite and occasional lignite chips; clay tends to have a waxy, soapy texture probably due to presence of micaceous minerals.
372.0-392.0':	No return, therefore probably a micaceous silica sand.

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-15

DEPTH m	DEPTH ft	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number
119–139	390–455		35, 60, 100, 65, 100	

GRAPHIC LOG



Description

392.0-402.0': Dominantly medium green-grey, stiff, slightly gritty, noncalcareous clay; both muscovite and lignite are absent in clay. Interval of recovered core commences with ≈3" of medium grey fine- to medium-grained subangular sand; within sand is a large lignite chip (≈1" across).

402.0-405.0': Possible sand interval.

405.0-437.0': Silty clay is medium green-grey; very fine-grained, medium stiff, noncalcareous; in some places very fine laminae may be observed within clay.

437.0': End of interval marked by a coarse-grained quartz sand.

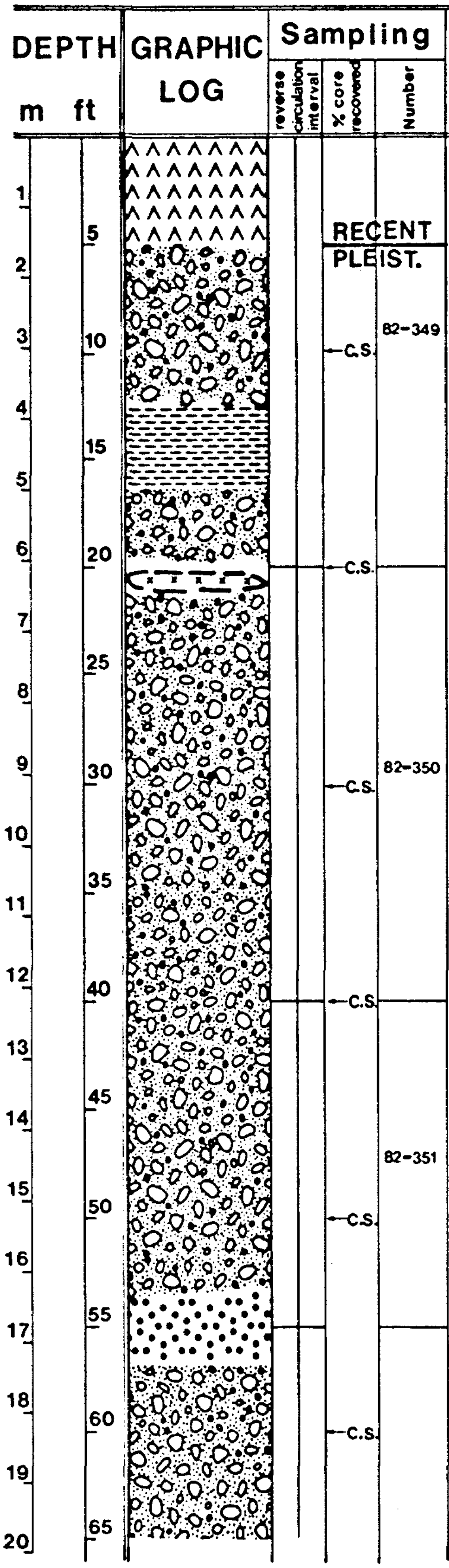
437.0': END OF HOLE.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-16   Location: CENTRAL HAMBLY TWP.

Elev. of collar: 328 ft   Sheet 1 of 7   (lat. 50°19'01"N long. 82°33'53"W)

DEPTH (m, ft)	GRAPHIC LOG	Sampling (reverse circulation interval, % core recovered, Number)	Description



MUSKEG: 0-5.0'

SANDY TILL: 5.0-12.0'
Grey-green clay with moderate amount of fine sand; calcareous. Thin iron stained beds present at top of unit. Pebble types are tan limestone and black siltstone.

CLAY: 12.0-16.0'
Brown clay becoming green by 13.0'; calcareous, slightly gritty. Wood chips at 15.0'.

SANDY TILL: 16.0-54.0'
Grey-green clay; sandy; calcareous; moderately stiff; several thin sand layers. Rock fragments predominantly angular limestone and other sedimentary rocks to 1-2 mm; amount of basement rock types increases after 22.0'.
21.0': Diabase boulder.

37.0': Clay becomes slightly stiffer.

41.0-42.0': Boulder - tan limestone.

47.0': Thin fine-grained brown polymictic sand layer <1" thick.

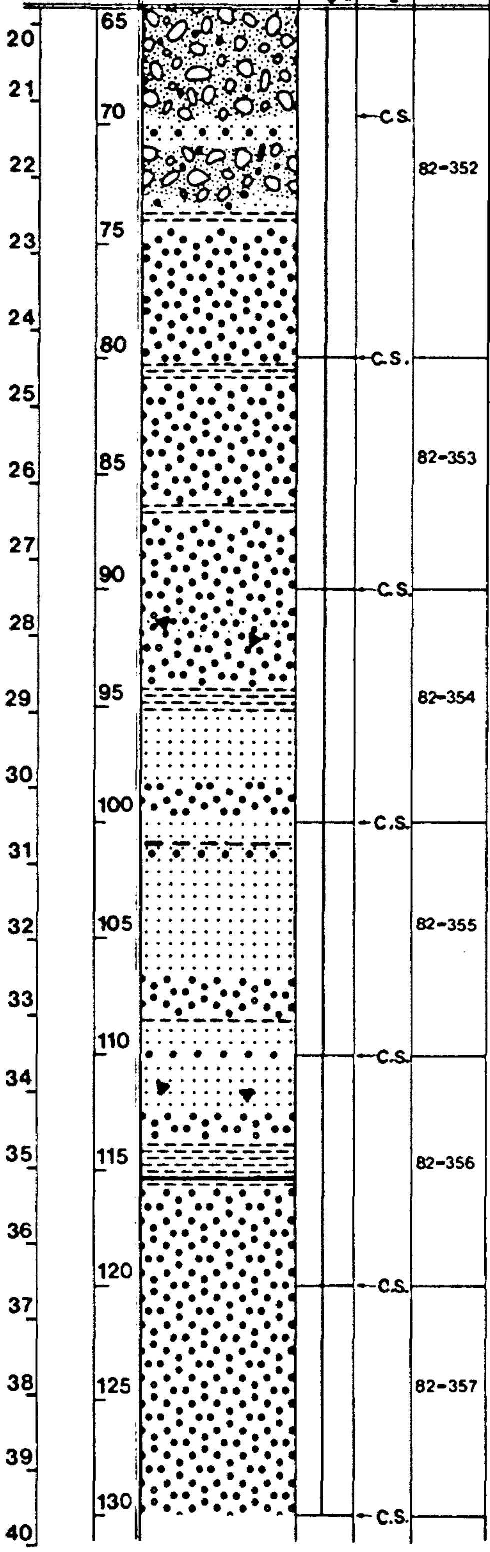
SAND AND GRAVEL: 54.0-56.0'
Fine-grained polymictic sand; pebble fraction ≈80% limestone; angular.

SANDY TILL: 56.0-71.0'
Same as 16.0-54.0'; predominantly fine-grained polymictic sand; pebble fraction 70% limestone, 30% chert.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-16

DEPTH (m, ft)	GRAPHIC LOG	Sampling (reverse circulation interval, % core recovered, Number)	Description



Description

70.0-70.5': Sand and gravel layer; sand is fine-grained, polymictic. Normal pebble suite; sedimentary/basement 60/40.

CLAY TILL: 71.0-73.0'

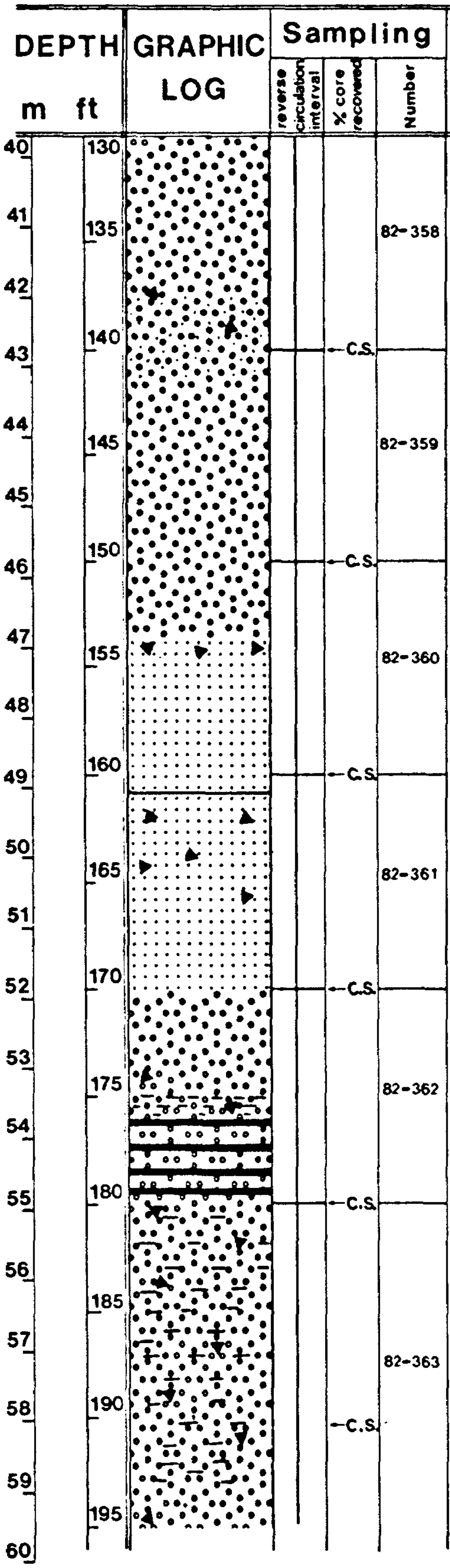
SAND AND GRAVEL WITH CLAY INTERBEDS: 73.0-169.5'

Sand is generally very fine- to coarse-grained, light brown polymictic. Clay interbeds are usually stiff grey-green, calcareous. Usually includes common pebble suite of limestone, chert, minor jasper, black siltstone, diabase, and granite.

73.0-73.5':	Fine sand and pebbles.
73.5-74.0':	Clay.
74.0-80.0':	Medium- to coarse-grained, polymictic sand with thin interbeds of stiff green-grey calcareous clay.
80.0-81.0':	Clay.
81.0-86.0':	Medium- to coarse-grained polymictic sand and pebbles.
86.0-86.5':	Clay.
86.5-94.0':	Same as 81.0-86.0'. Fine-grained sand.
90.0-90.5':	Minor shell fragments noted. Lignite and wood chips observed immediately below the fine sands; pebbles predominantly limestone to 3/4".
94.0-95.0':	Clay.
95.0-97.0':	Fine sand, polymictic; grades into medium to coarse sand and pebbles (sedimentary 60%, basement 40%); unit appears graded.
97.0-107.0':	Thin graded sequences; clay very fine-grained to fine-grained sand, medium to coarse sand, pebbles, repeat.
107.0-110.5':	Becomes ≈60% quartz grains; medium-grained. Sand is immature.
110.5-115.0':	New sequence; unit contains lignite chips and thin clay layers.
115.0-115.3':	Possible lignite seam.
115.3-137.0':	Fine- to medium-grained; light grey immature sand; 90% quartz, 10% chert; lignite and miscellaneous grains.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-16



Description

137.0-139.0': Fine-grained sand; predominantly quartz with abundant lignite chips.
139.0-140.0': Medium to coarse sand.
140.0-141.0': Fine to medium sand.
141.0-153.0': Medium to coarse sand.

153.0-169.5': Fine-grained sand; minor mica; lignite makes up ≈20% of sample between 153.0-154.0'; and 20-30% of sample between 160.0-167.0'.

PEBBLE SAND: 169.5-173.0'
Bimodal; pebbles of granite, limestone, chert; sand is medium grey, fine- to medium-grained, polymictic; calcareous; contains minor mica and lignite.

CLAYEY SAND: 173.0-192.0'
Sand is medium grey, fine- to medium-grained, polymictic; calcareous; submature; clay is light grey with limestone clasts and minor lignite.
176.0-180.0': Lignite comprises 50-60% of sample; possible seam.
180.0-192.0': Decrease in lignite content to <15%; light green gritty clay dominates; rock fragments include dark basement, quartz, and chert.

SAND: 192.0-216.0'
Predominantly coarse sand; less pebble size material; lignite chips still <15% of sample.

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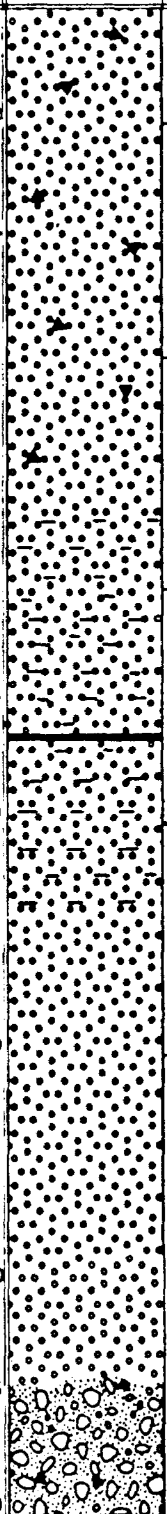
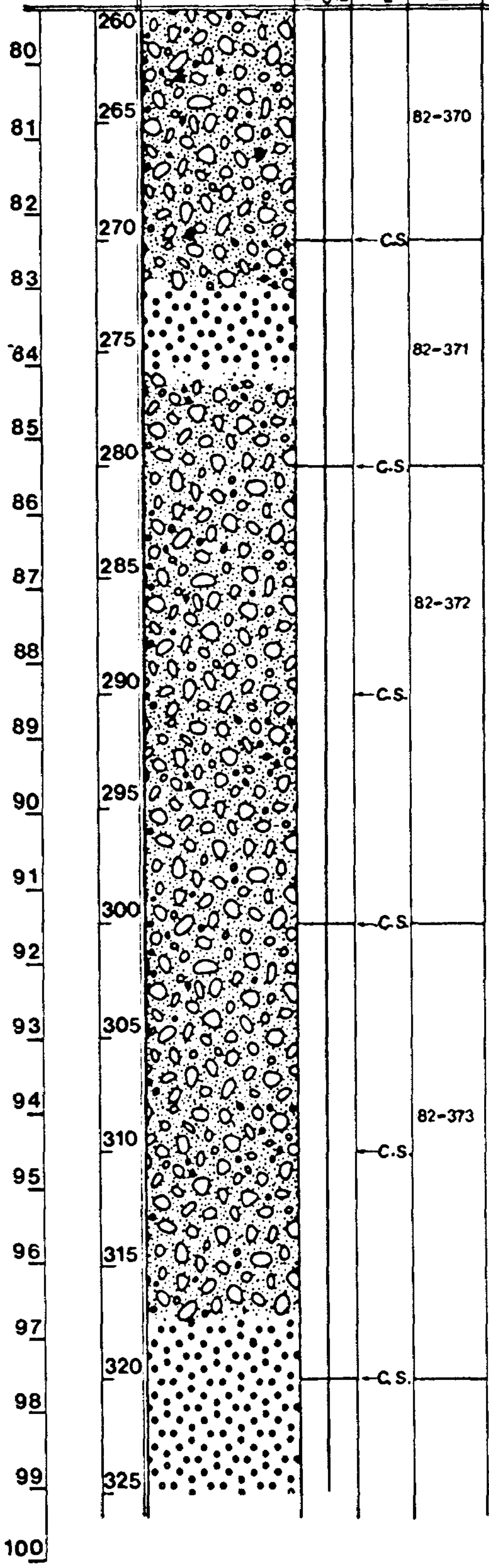
Drill Hole Nº: ONEX-82-16

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
60–61	195–200			C.S.	82-363	
61–64	200–210			C.S.	82-364	
64–67	210–220			C.S.	82-365	PEBBLE SAND: 216.0-234.0' Very coarse-grained, polymictic sand (predominantly quartz) with light green clay. Pebble suite comprises ≈20% of unit and includes subangular to angular limestone, granite, and chert.
67–70	220–230			C.S.	82-366	226.0': Very thin (<1") seam(?) lignite.
70–73	230–240			C.S.	82-367	PEBBLE SAND: 234.0-248.0' Similar to 216.0-234.0' except clay is now light to medium grey.
73–76	240–250			C.S.	82-368	CLAYEY SAND: 248.0-254.0' Light grey, very fine-grained sand, calcareous, submature; with light green clay; minor lignite chips; rock fragments of limestone and basement.
76–80	250–260			C.S.	82-369	CLAY TILL: 254.0-272.0' Medium grey soft, calcareous, clay. Grit portion of till consists of light grey, fine-grained, polymictic sand. Numerous subangular to subrounded clasts present; includes limestone, granite, chert, and jasper; minor lignite chips.



Drill Hole Nº: ONEX-82-16

DEPTH (m, ft) | GRAPHIC LOG | Sampling (reverse circulation interval, % core recovered, Number) | Description



269.0-270.0': Boulder — dark green basement rock.

PEBBLE SAND: 272.0-275.0'
Bimodal; sand is light grey, fine- to medium-grained, polymictic; slightly calcareous; submature. Minor grey clay present. Pebble size material is angular and includes mostly limestone, quartz, and basement fragments.

CLAY TILL: 275.0-280.0'
Similar to 254.0-272.0' except that lignite chips no longer apparent and sand content varies.

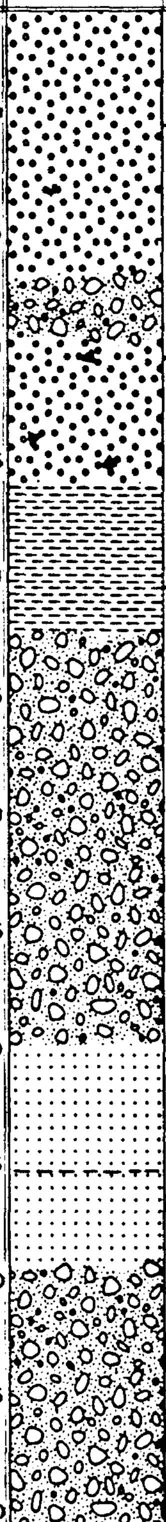
SANDY TILL: 280.0-318.5'
Unit is grey-brown colour, calcareous; sand fraction is fine-grained; pebbles <3 mm, rounded to subangular; basement rocks 60%, sedimentary 40%.

293.0': Boulder — diabase ≈½'.
294.0': Boulder — limestone ≈½'.

299.5': Boulder — ≈½'.

316.0-317.0': Pebble and cobble layer.

SAND AND GRAVEL: 318.5-336.0'
Fine to coarse sand; predominantly quartz; immature; pebbles are normal suite; rounded; minor lignite chips present.

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
100–101	325–330			CS	82-374	
101–104	330–340			CS	82-375	
104–107	340–350			CS	82-376	
107–110	350–360			CS	82-377	
110–113	360–370			CS		
113–116	370–380			CS	82-378	
116–119	380–390			CS	82-379	

333.5-336.0': Appearance of medium green-grey, gritty, calcareous clay; stiff; occurs as ≈10% of interval.

CLAY: 336.0-336.5'
Medium green, non-gritty, calcareous; soft; pebbles now absent.

PEBBLE SAND TILL: 336.5-338.0'
Fine- to coarse-grained sand, polymictic although predominantly quartz. Minor pyrite present. Sand is submature. Light green calcareous clay present. Pebbles <3 mm, subangular to subrounded.

CLAY TILL: 338.0-339.5'
Medium grey-green, calcareous, soft clay; minor polymictic granule sized clasts present (<15%). Proportion increases with depth. Clasts angular to rounded.

SAND AND GRAVEL: 339.5-345.0'
Sand is coarse-grained, polymictic, calcareous, immature. Minor clay present; contains ≈10% lignite chips. Pebbles 40% sedimentary limestone, chert, black siltstone, and 50% basement mafics and quartz. Clasts become more rounded towards bottom unit.

CLAY: 345.0-351.0'
Medium grey, calcareous, soft; minor amount of very fine-grained sand. Few granular size clasts present; dominantly limestone with little basement material.

CLAY TILL: 351.0-368.5'
Similar to 345.0-351.0' with increased sand and clast content.

SAND: 368.5-378.0'
Predominantly very fine-grained sand and silt; very poor return.

- 368.5-370.0': Few angular pebbles; minor wood chips.
- 370.0-374.0': Silt with 2-3% mica, 2-3% very fine lignite chips, 5-10% dark grains.
- 374.0': Thin calcareous clay layer; moderately stiff.

CLAY TILL: 378.0-389.5'
Green-grey clay; calcareous with fine- to medium-grained sand. Pebble material present; angular to rounded basement and sedimentary material (70/30).

PEBBLE SAND: 389.5-430.0'
Fine-grained sand with scattered pebbles; occasional minor lignite chips.

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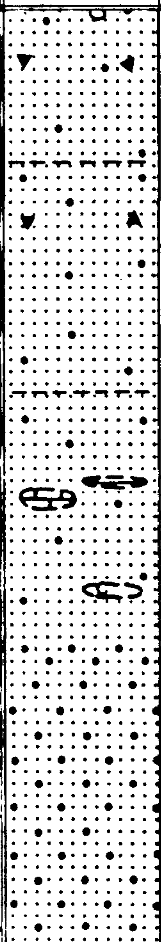
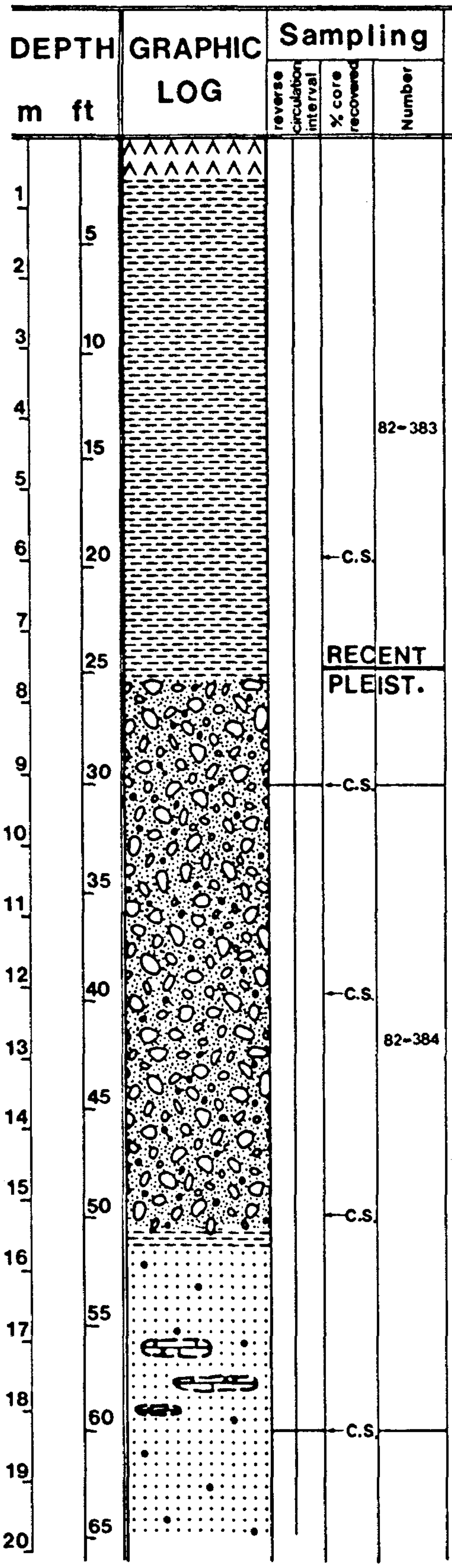
Drill Hole Nº: ONEX-82-16

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
119	390					
120						
	395				82-380	
121						396.0': Thin layer of green-grey calcareous clay.
122	400			C.S.		
23						
	405				82-381	
124						406.0': Same as 396.0'.
						409.0': Boulder — limestone; small.
125	410			C.S.		410.0': Boulder — limestone; small.
126						
	415					414.0': Boulder — chert; small.
127						415.0-430.0': Hit pressurized water; washed large amount of gravel up hole.
					82-382	
128	420			C.S.		
129						
	425					
130						
131	430			C.S.		430.0': END OF HOLE.
132						
	435					
133						
134	440					
135						
	445					
136						
137	450					
138						
	455					
139						

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-17 Location: SE HABEL TWP.

Elev. of collar: 312 ft Sheet 1 of 7 (lat. 50°22'40" N long. 82°32'36" W)



Description

MUSKEG: 0-2.0'

MARINE CLAY: 2.0-25.0'

2-12.0': Blue-grey calcareous clay with bivalves.

12.0-25.0': Dark grey calcareous clay, very soft; minor sand throughout; bivalves present; minor wood and lignite chips; pebbles include chert, diabase, and black siltstone.

CLAY TILL: 25.0-51.0'

Green-grey calcareous clay; minor sand; moderate number of pebbles to 44.0', few after; predominantly sedimentary pebbles - limestone, chert, minor jasper.

CLAY: 51.0-51.5'

Stiff brown calcareous clay.

GRAVELS AND SANDS: 51.5-108.0'

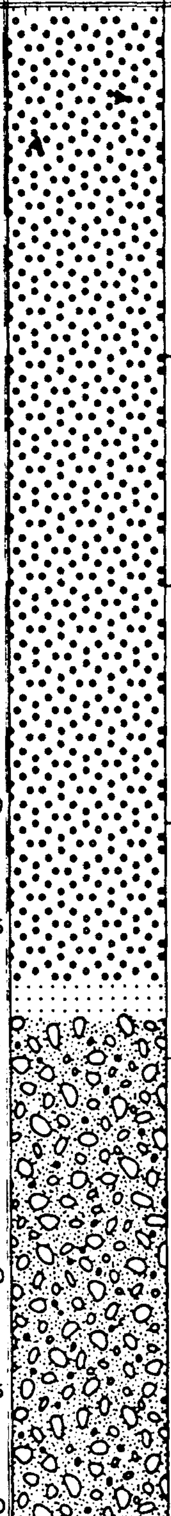
Rapidly alternating coarse and pebble-cobble gravels and sands. Beds up to ≈1' thick, most are very thin. Sand is predominantly fine- to medium-grained from 51.5-66.0'.

56.0-59.0': Several boulders of limestone and diabase.

Drill Hole Nº: ONEX-82-17

DEPTH m	DEPTH ft	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number
20	65			
21	70		C.S.	
22				82-385
23	75			
24	80		C.S.	
25				
26	85			82-386
27	90		C.S.	
28				
29	95			82-387
30	100		C.S.	
31				
32	105			82-388
33				
34	110		C.S.	
35	115			
36				82-389
37	120		C.S.	
38	125			
39				
40	130		C.S.	

GRAPHIC LOG



Description

66.0-107.0': Sand is predominantly medium- to coarse-grained and approximately 60% angular to subrounded quartz grains. Pebbles are rounded to angular; 80% limestone, chert, jasper, and black siltstone; 20% diabase.

72.0': Lignite chips.

89.0': Wood chips.

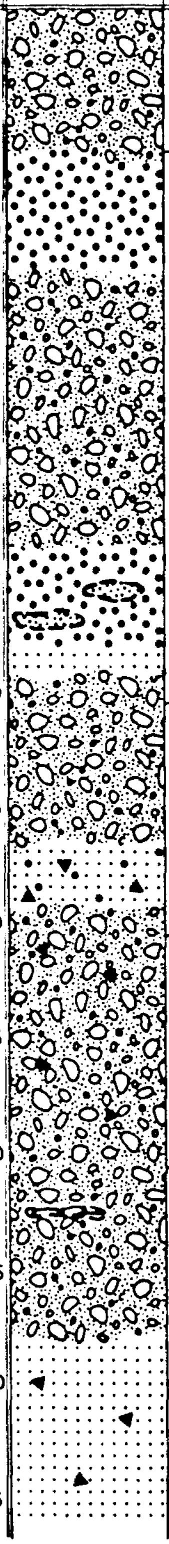
107.0-108.0': Light brown fine-grained polymictic sand.

TILL: 108.0-137.0'

108.0-113.0': Green-grey calcareous clay with minor fine-grained polymictic sand and fine lignite chips; moderately stiff.

113.0-137.0': Green-grey calcareous clay; stiff; sand content varies throughout interval; little sand until 128.0' then slight increase.

Drill Hole Nº: ONEX-82-17

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
40–60	130–195			C.S. (43 m); C.S. (46 m); C.S. (49 m); C.S. (52 m); C.S. (55 m); C.S. (58 m)	82-390; 82-391; 82-392; 82-393; 82-394	

PEBBLE/COBBLE BED: 137.0-140.5'
Pebbles predominantly rounded to subrounded; 60% limestone, chert, black siltstone, 40% diabase and granite. Minor medium to coarse sand.

CLAY TILL: 140.5-153.0'
Similar to 113.0-137.0'.

PEBBLE/COBBLE BED: 153.0-158.0'
Similar to 137.0-140.5'. Sand predominantly coarse.
156.0-158.0': Several large cobbles; thin layer of fine sand at 158.0'.

TILL: 158.0-166.0'
Similar to 113.0-137.0'.

SAND AND GRAVEL: 166.0-168.0'
Light brown fine-grained polymictic sand; gravel consists of angular to subrounded pebbles; minor lignite.

SAND PEBBLE TILL: 168.0-178.5'
Fine-grained polymictic sand with subangular to subrounded pebbles; predominantly limestone (70%), basement (15%), and quartz (15%); minor lignite chips.

TILL: 178.5-182.0'
Green-grey calcareous clay; hard, brittle. Minor quartz sand with ≈20% dark grains; occasional limestone or diabase pebble.

SANDY TILL: 182.0-187.0'
Sand is polymictic fine- to medium-grained with clay and moderate amount of subrounded to angular pebbles and rock fragments.
182.5': Limestone boulder.

SANDS WITH LIGNITE: 187.0-261.0'
Predominantly very fine- to fine-grained polymictic sand; contains 2-3% mica; 1-3% lignite chips; some brown lignite and occasional wood chips; minor sandstone fragments; minor pebble suite present. Infrequent thin green-grey calcareous soft clay layers.
194.5': Wood chips.

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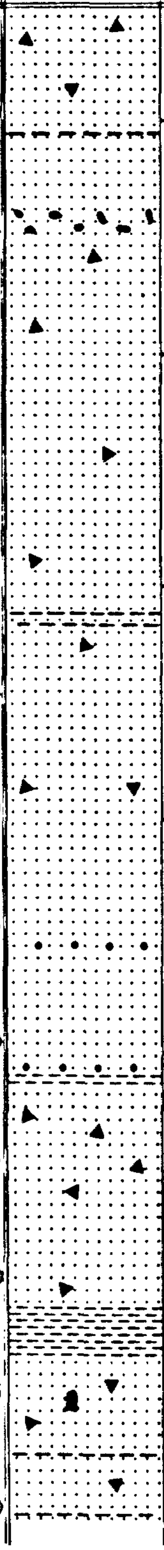
Drill Hole Nº: ONEX-82- 17

DEPTH: m 60–80; ft 195–260

GRAPHIC LOG



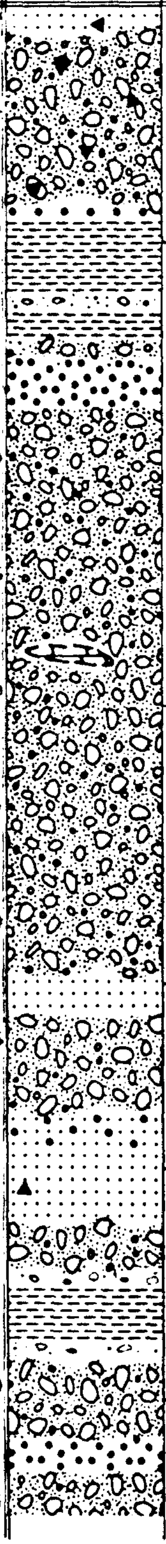
Sampling: reverse circulation interval; % core recovered; Number

Sample Number	Interval (ft)	Description
82-395	195–200 (C.S.)	
82-396	200–210 (C.S.)	204.0-205.0': Medium to coarse sand; submature. 205.0-208.0': Trace lignite.
82-397	210–220 (C.S.)	Number of pebbles increase after 214.0'.
82-398	220–230 (C.S.)	After 220.0' only minor lignite chips except for enriched intervals. After 222.0' occasional thin brittle clay layers; green-grey, calcareous, gritty clay (claystone). 228.0-229.0': Lignite chips 2-3%.
82-399	230–240 (C.S.)	
82-400	240–250 (C.S.)	241.0': Claystone layer. 243.0-246.0': Lignite chips 1-2%.
82-401	250–260 (C.S.)	250.5-253.0': Claystone layer. 254.0': Piece of shell. 257.0': ≈1" layer very soft green-grey calcareous clay. 259.5': Same as 257.0'.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole No: ONEX-82-17

Sheet 5 of 7

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number
80–100	260–325			C.S. (270); C.S. (280); C.S. (290); C.S. (302); C.S. (310); C.S. (321)	82-402; 82-403; 82-404; 82-405; 82-406; 82-407

Description

CLAY TILL: 261.0-269.0'
Green-grey calcareous clay; minor grit; occasional rounded to subangular pebbles of limestone and quartz; minor lignite chips; possibly a few fine sand seams (cave?).
267.5-268.5': 25% lignite chips.
268.0-269.0': Cobble bed; basement quartz, mafics.

CLAY: 269.0-272.0'
Medium grey-green, slightly gritty clay; calcareous to 271.0'; noncalcareous 271.0-272.0'; trace lignite chips; no pebbles or clasts.

SAND: 272.0-272.5'
Medium-light grey, polymictic, slightly calcareous; sand composed predominantly of white quartz and usual rock suite; fine- to coarse-grained, angular to subangular; lignite 20% of interval.

CLAY: 272.5-274.0'
Similar to 269.0-271.0'.

CLAY TILL: 274.0-275.0'
Medium grey, slightly calcareous, gritty, medium stiff. Contains ≈15% angular to subangular clasts; dominantly limestone, chert, and quartz; occasional basement clast.

SAND: 275.0-276.0'
Similar to 272.0-272.5'.

PEBBLE SAND: 276.0-277.0'
Very light grey to white; noncalcareous. Grain size is very fine-grained to pebble; contains up to 15% lignite chips; ≈10% clay blebs.

CLAY TILL: 277.0-279.0'
Similar to 274.0-275.0'; clay less stiff; 40% clasts.

PEBBLE SAND TILL: 279.0-280.5'
Similar to 276.0-277.0', but 25% clay.

CLAY TILL: 280.5-286.5'
Brown-green calcareous clay, gritty, stiff. Pebbles 1-2%, predominantly quartz and greenstone.

CLAY TILL: 286.5-302.0'
Green-grey calcareous clay, stiff; grit content varies from little to none; pebbles; trace lignite.
287.0': Boulder - tan limestone.

SAND: 302.0-303.0'
Fine-grained, polymictic.

CLAY TILL: 303.0-306.0'
Similar to 286.5-302.0'; no lignite.

SAND: 306.0-306.5'
Light grey-brown, fine to coarse with lignite chips.

CLAY TILL: 306.5-307.0'
Similar to 286.5-302.0' with 1-2% white quartz pebbles and medium to coarse sand.

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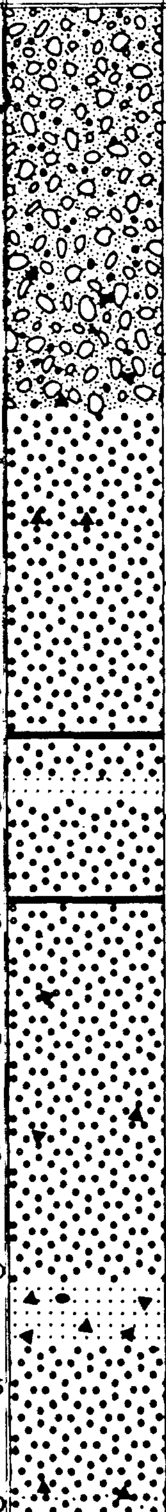
Drill Hole Nº: ONEX-82-17

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number
100	325, 330			C.S.	
101, 102, 103	335, 340			C.S.	82-408
104, 105, 106	345, 350			C.S.	82-409
107, 108, 109	355, 360			C.S.	82-410
110, 111, 112	365, 370			C.S.	82-411
113, 114, 115	375, 380			C.S.	82-412
116, 117, 118, 119	385, 390			C.S.	82-413



Description

PEBBLE SAND: 307.0-309.5'
Light grey, fine to coarse sand and pebbles; predominantly angular to rounded quartz; ≃10% other rock types; minor clay, minor lignite chips.

FINE SAND: 309.5-312.0'
Predominantly fine sand with thin stiff clay layers. Sand is light grey with white mica and 1-2% dark grains; minor coarse sand and pebbles; minor lignite chips.

CLAY TILL: 312.0-314.0'

SAND: 314.0-314.5'
Fine- to coarse-grained; predominantly quartz.

CLAY: 314.5-317.0'
Light grey, calcareous, medium stiff.

SAND: 317.0-317.5'
Same as 314.0-314.5' with lignite chips.

CLAY TILL: 317.5-325.5'
With pebble sand layers; minor lignite chips; sand seam at 325.0'.

SAND PEBBLE TILL: 325.5-342.0'
335.0-340.0': Increase in amount of lignite chips.

PEBBLE SAND: 342.0-393.0'
Sand is fine- to coarse-grained, light brown, polymictic; coarse sand is predominantly clear quartz, subrounded to subangular; pebbles rounded to subrounded; chert, quartz, limestone, diabase, jasper.
354.0-357.0': ≃10% lignite chips; possible thin seam lignite at 356.0'.

379.0-382.0': 3-5% lignite chips in fine sand; minor number of wood chips.

388.0-388.5': Lignite chips in fine sand.

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX - 82 - 17

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
119–120	390–393				82-414	393.0': END OF HOLE.

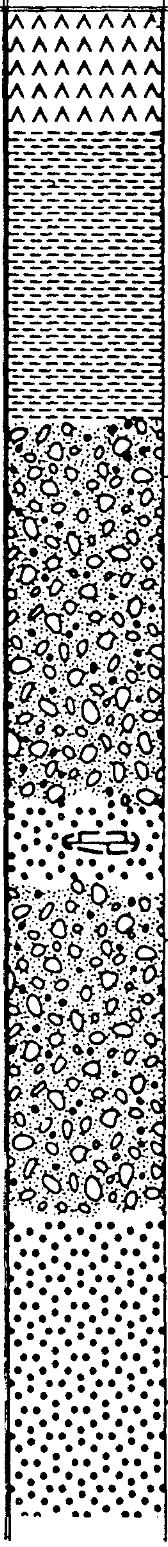
m: 119, 120, 121, 122, 23, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139

ft: 390, 395, 400, 405, 410, 415, 420, 425, 430, 435, 440, 445, 450, 455

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

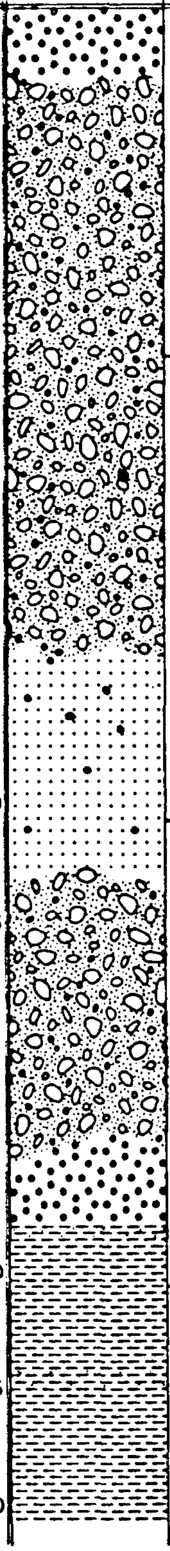
Drill Hole Nº: ONEX-82-18 Location: NORTH-CENTRAL McCAUSLAND TWP.

Elev. of collar: 272 ft Sheet 1 of 7 (lat. 50°21'41" N long. 82°23'15" W)

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
0–2	0–5					MUSKEG: 0-5.0'
2–5	5–17		NS		NS	MARINE CLAY: 5.0-17.0' Light-medium blue-grey, very soft, extremely calcareous clay. Non-gritty with shell fragments and minor organic debris.
	17			RECENT / PLEIST.		
5–10	17–33			C.S.	82-415	SANDY TILL: 17.0-33.0' Medium-light grey clay matrix, gritty, very calcareous, soft; medium-grained polymictic sand clasts; 50/50 basement to sedimentary, angular to subangular, moderate sphericity.
10–11	33–37					SANDY GRAVEL: 33.0-37.0' Absence of clay; becoming a sandy gravel with normal pebble suite - limestone, chert, granite, mafics, quartz, etc. 35.0-35.5': Sedimentary boulder, dominantly limestone.
11–16	37–53			C.S. / C.S.	82-416	SANDY TILL: 37.0-53.0' As above; reappearance of medium grey, soft, very calcareous, gritty clay, thus a sandy till. Normal pebble suite; angular clasts, moderate sphericity. Polymictic sand, medium- to coarse-grained, immature.
16–20	53–67			C.S.	82-417	SAND: 53.0-67.0' Very fine-grained to coarse-grained, polymictic calcareous sand. Immature with 30% sedimentary and basement pebble-sized angular to subangular clasts; ≈65% sedimentary clasts - limestone, black siltstone, chert; and 35% basement - mafics, granite, and quartz.

1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-18

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
20	65					
21	70			←C.S.		SANDY TILL: 67.0-93.0' As above; clay matrix is a light grey-beige; sample is 20% clay, 35% clasts, and 45% sand.
22					82-417	
23	75					
24	80			←C.S.		
25						
26	85					
27	90			←C.S.	82-418	
28						SANDY GRAVEL: 93.0-101.0' Absence of clay; very fine-grained, calcareous, light beige sand containing ≃50% clasts having moderate sphericity, angular to subangular. Sedimentary and basement clasts ≃60/40; normal pebble suite.
29	95					
30	100			←C.S.		
31						SANDY PEBBLE TILL: 101.0-106.0' Subrounded to rounded pebbles having moderate sphericity, in a fine-grained polymictic sand as above. Normal pebble suite with 50/50 sedimentary to basement. Medium green-grey, calcareous, gritty, soft clay comprises 15%.
32	105					
33	110			←C.S.	82-419	CLAY TILL: 106.0-114.0' Clay matrix as above but now constitutes 40% of sample. Normal pebble suite with sedimentary and basement clasts as 50/50. 113.0-114.0': Boulder, black siltstone, white chert, limestone.
34				PLEIST.		
35	115			CRETAC.		SILICA SAND: 114.0-116.0' Medium- to coarse-grained white dominantly quartz (minor chert) sand with white clay and occasional quartz pebbles; subangular to subrounded grains, moderately mature grains.
36	120			←C.S.		
37						VARIEGATED CLAY SEQUENCE: 116.0-139.0' Thinly layered and laminated brightly coloured clays varying from white, yellow, grey, green, peach, and brick red. Clays are noncalcareous, soft to medium stiff, and non-gritty to gritty. Sequence includes small seams of silica sand.
38	125				82-420	
39	130			←C.S.		
40						

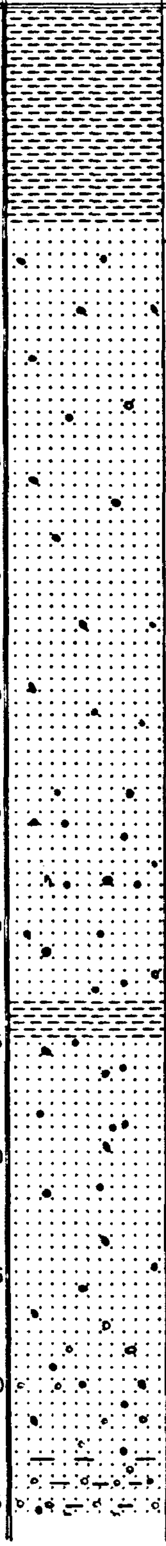
1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole No: ONEX-82-18

Sheet 3 of 7

DEPTH m	DEPTH ft	Sampling: Number	Description
40	130		
41	135	82-420	
42			
43	140	C.S.	SILICA SAND: 139.0-285.0' 139.0-164.0': White silica sand with muscovite; very fine-grained to coarse-grained; 90% quartz, subangular to subrounded grains, moderate sphericity; minor amounts of white gritty, noncalcareous, medium stiff white clay.
44	145	82-421	
45			
46	150	C.S.	
47	155	82-422	
48			
49	160	C.S.	
50	165	82-423	164.0-172.0': Yellow, grey, clear quartz; coarse-grained to pebble-sized; still some fine to medium grains; minor chert and jasper.
51			
52	170	C.S.	
53	175	82-424	172.0-173.0': Light to medium grey, gritty clay, non-calcareous, becoming non-gritty, medium stiff; minor purple and green varves. 173.0-174.0': Grey-brown clay as above. 174.0-180.5': Silica sand as 164.0-172.0'.
54			
55	180	C.S.	180.5-182.0': Silica sand, medium- to coarse-grained, some pebbles - quartz, chert, black siltstone; rounded grains.
56	185	82-425	182.0-183.5': Fine-grained silica sand, micaceous. 183.5-192.0': Same as 180.5-182.0' with kaolin-rich clay.
57			
58	190	C.S.	
59	195	82-426	192.0-197.0': Medium- to coarse-grained silica sand; minor red-grey clay, stiff, noncalcareous.
60			

Graphic log:

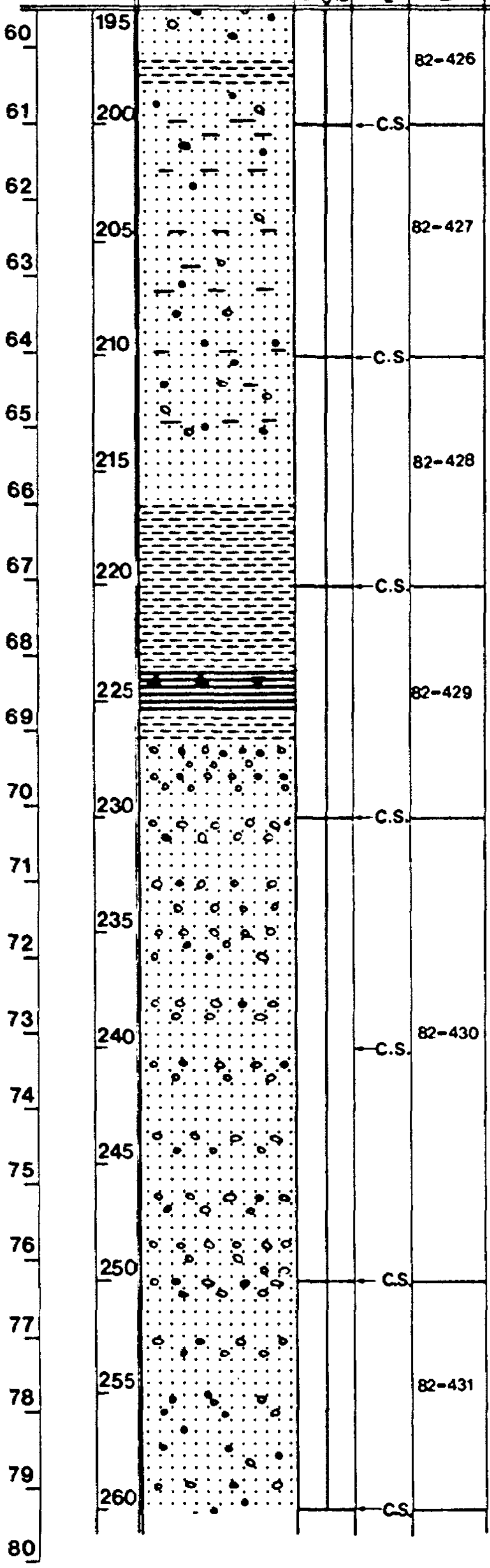


Sampling columns: reverse circulation interval; % core recovered; Number

1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

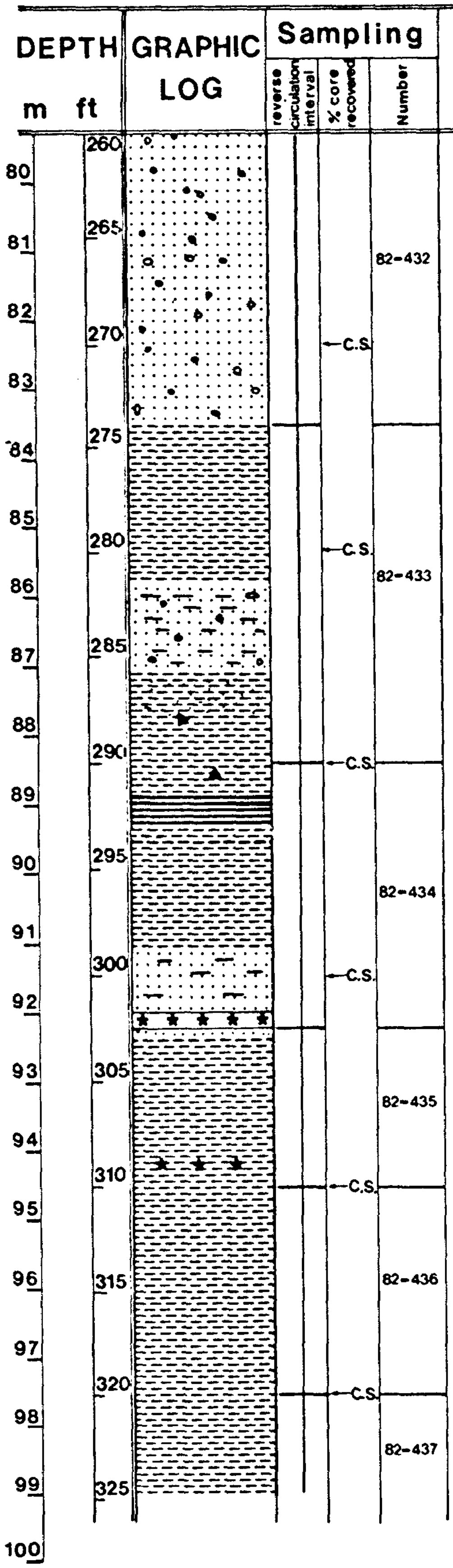
Drill Hole Nº: ONEX-82-18

DEPTH (m, ft)	GRAPHIC LOG	Sampling (reverse circulation interval, % core recovered, Number)	Description



197.0':	Clay interbed, white to light grey, stiff, noncalcareous and coarse pebble sand.
198.0':	Silica sand similar to 164.0-172.0'; minor kaolinite clay.
204.0':	Pebble to coarse-grained silica sand, minor jasper, kaolinite clay; predominantly angular grains, medium sphericity.
214.0':	Fine-grained silica sand.
216.0':	Light grey stiff, noncalcareous, non-gritty clay.
222.0':	Medium grey clay as above.
223.0':	Very dark grey carbonaceous clay as above with minor lignite; woody texture apparent.
225.0':	Medium to light beige clay as 216.0-222.0'.
226.0':	Silica sand, fine-grained to very coarse-grained, subangular to subrounded quartz grains, having moderate sphericity. Minor muscovite (≈5%) and white very soft clay blebs. Graded - ≈5 coarsening upward cycles occurring over a 10.0' interval.
254.0-267.0':	Very coarse-grained to pebble-sized fragments of silica sand; angular to subangular with moderate sphericity.

Drill Hole Nº: ONEX-82-18



Description

267.0-273.0': Fine- to coarse-grained silica sand with ≈10% impurities, basement and/or black siltstone clasts.

273.0-281.0': White, noncalcareous, non-gritty, soft kaolinite clays.

281.0-285.0': Silica sand, very fine-grained, dominantly quartz with minor white clay and conspicuous flakes of muscovite.

CLAY SEQUENCE: 285.0-298.5'

Clay dark, medium, and light grey, noncalcareous, slightly gritty, soft to medium stiff; minor lignite chips at 288.2'; becoming carbonaceous from 292.0-293.5'.

SILICA SAND: 298.5-301.0'

With clasts of extremely sandy clay; sand possibly includes minor clay.

CLAY: 301.0-327.0'

Dark grey, brownish-grey, tan, yellow, light grey, and white clay. Slightly gritty, noncalcareous, moderately stiff to stiff. Carbonaceous at 301.0-301.5' with fine- to medium-grained pyrite and silica sands.

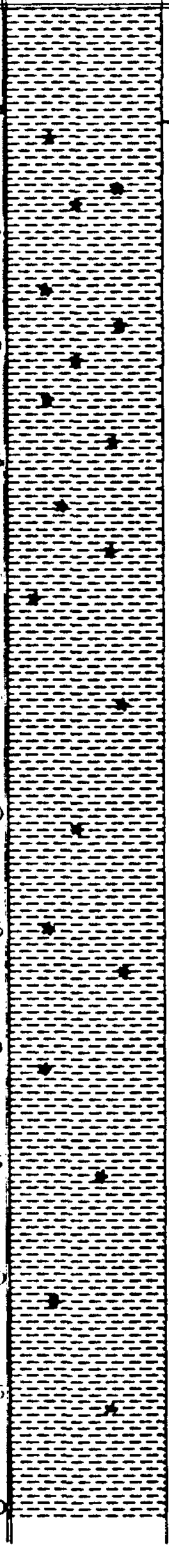
302.0-302.1': Small seam of silica sand ≈1" thick.

307.0-307.5': Clay with nodules (1-2 mm spherical) of pyrite and possibly chert.

310.5-327.0': Clays appear to be varved.

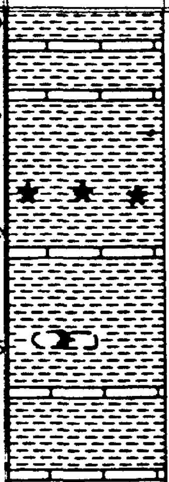
1982 DRILLING PROGRAM-JAMES BAY LOWLANDS

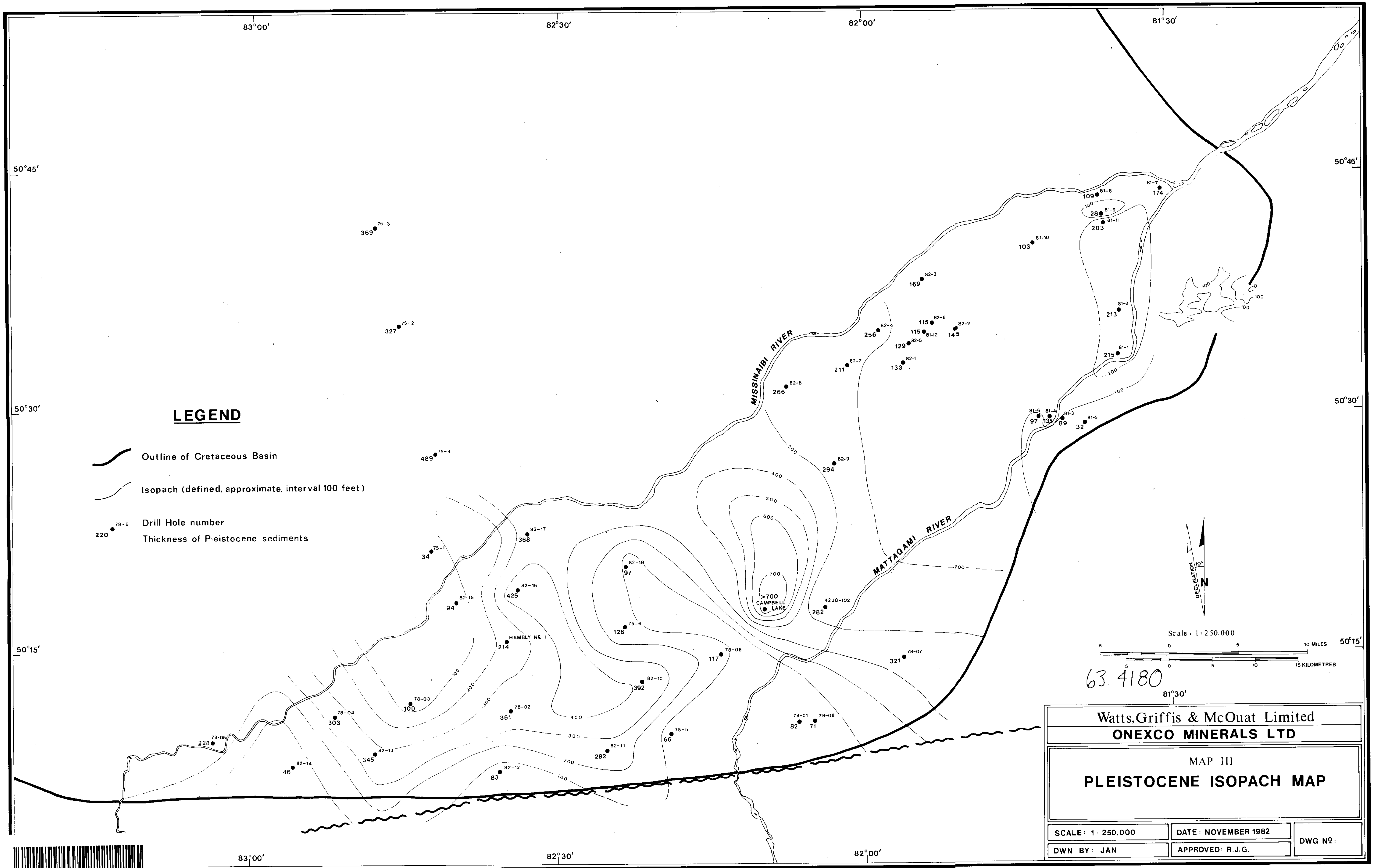
Drill Hole Nº: ONEX-82-18

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
	325			CRETAC. / DEVON		SHALE AND CLAYSTONE SEQUENCE: 327.0-382.0' Very dark brown to black fairly well-indurated yet fissile, oil shale containing iron sulphide as conspicuous blebs and euhedral crystals. Shale includes interbeds of dark brown and light green sandy, gritty, noncalcareous claystone. In places very fine bedding may be observed in shales.
100	330			C.S.	82-437	
101–104	335–340			100		
104–107	345			100		345.0-347.0': Possible small scale slump structrues and/or rip-up clasts in evidence at 1' intervals. 346.0-349.0': Shale is extremely friable.
107–110	350–355			100		356.0': Possible small scale slump structures.
110–113	360–365			100		361.0-371.0': Iron sulphide occurs as very fine crystals along bedding planes. At 361.0' possible slump features.
113–116	370–375			100		
116–119	380–390			100		CLAYSTONE: 382.0-391.0' Light grey-green, noncalcareous, slightly gritty, well-indurated claystone; iron sulphide occurs as disseminated euhedral crystals; nodular bedding may be observed at 383.2', pyrite nodule (¼" thick) is enclosed in a light beige chert.

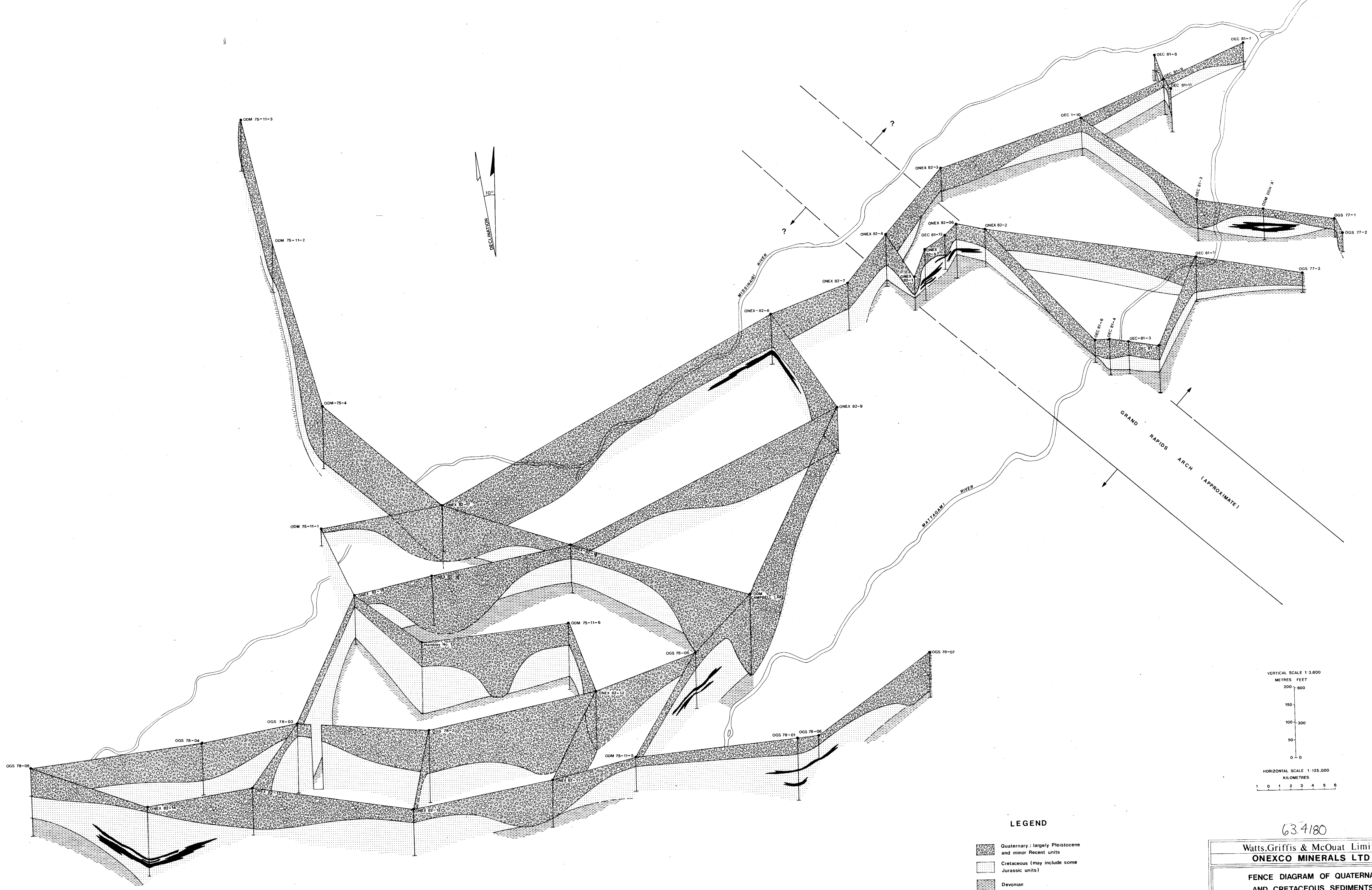
1982 DRILLING PROGRAM - JAMES BAY LOWLANDS

Drill Hole Nº: ONEX-82-18

DEPTH m	DEPTH ft	GRAPHIC LOG	Sampling: reverse circulation interval	Sampling: % core recovered	Sampling: Number	Description
119	390					CLAYSTONE/LIMESTONE: 391.0-410.0'
120						Light grey-green, calcareous, slightly gritty, well-indurated claystone. Similar to above (381.0-391.0') except calcareous. Iron sulphide occurs as disseminated crystals and nodules. Claystone includes interbeds of light grey-green limestone from 2" to 4" thick.
	395			97		
121						
122	400					397.6': Pyrite layer up to ⅛" thick.
23						403.9': Pyrite nodule ¼-½" thick.
	405			100		
124						
125	410					410.0': END OF HOLE.
126						
	415					
127						
128	420					
129						
	425					
130						
131	430					
132						
	435					
133						
134	440					
135						
	445					
136						
137	450					
138						
	455					
139						


83°00'
82°30'
82°00'
81°30'
50°45'
50°30'
50°15'
LEGEND
Outline of Cretaceous Basin
Isopach (defined, approximate, interval 100 feet)
Drill Hole number
Thickness of Pleistocene sediments
MISSINAIBI RIVER
MATTAGAMI RIVER
CAMPBELL LAKE
>700
HAMBLY Nº 1
DECLINATION 10°
N
Scale : 1 : 250,000
10 MILES
15 KILOMETRES
63.4180
Watts,Griffis & McOuat Limited
ONEXCO MINERALS LTD
MAP III
PLEISTOCENE ISOPACH MAP
SCALE : 1 : 250,000
DATE : NOVEMBER 1982
DWG Nº :
DWN BY : JAN
APPROVED : R.J.G.

200



VERTICAL SCALE 1:3,600

METRES FEET

200 – 600
150
100 – 300
50
0 – 0

HORIZONTAL SCALE 1:125,000

KILOMETRES

1 0 1 2 3 4 5 6

LEGEND

- Quaternary: largely Pleistocene and minor Recent units
- Cretaceous (may include some Jurassic units)
- Devonian
- Lignite

63.4180

Watts, Griffis & McOuat Limited

ONEXCO MINERALS LTD

FENCE DIAGRAM OF QUATERNARY AND CRETACEOUS SEDIMENTS IN THE JAMES BAY LOWLAND

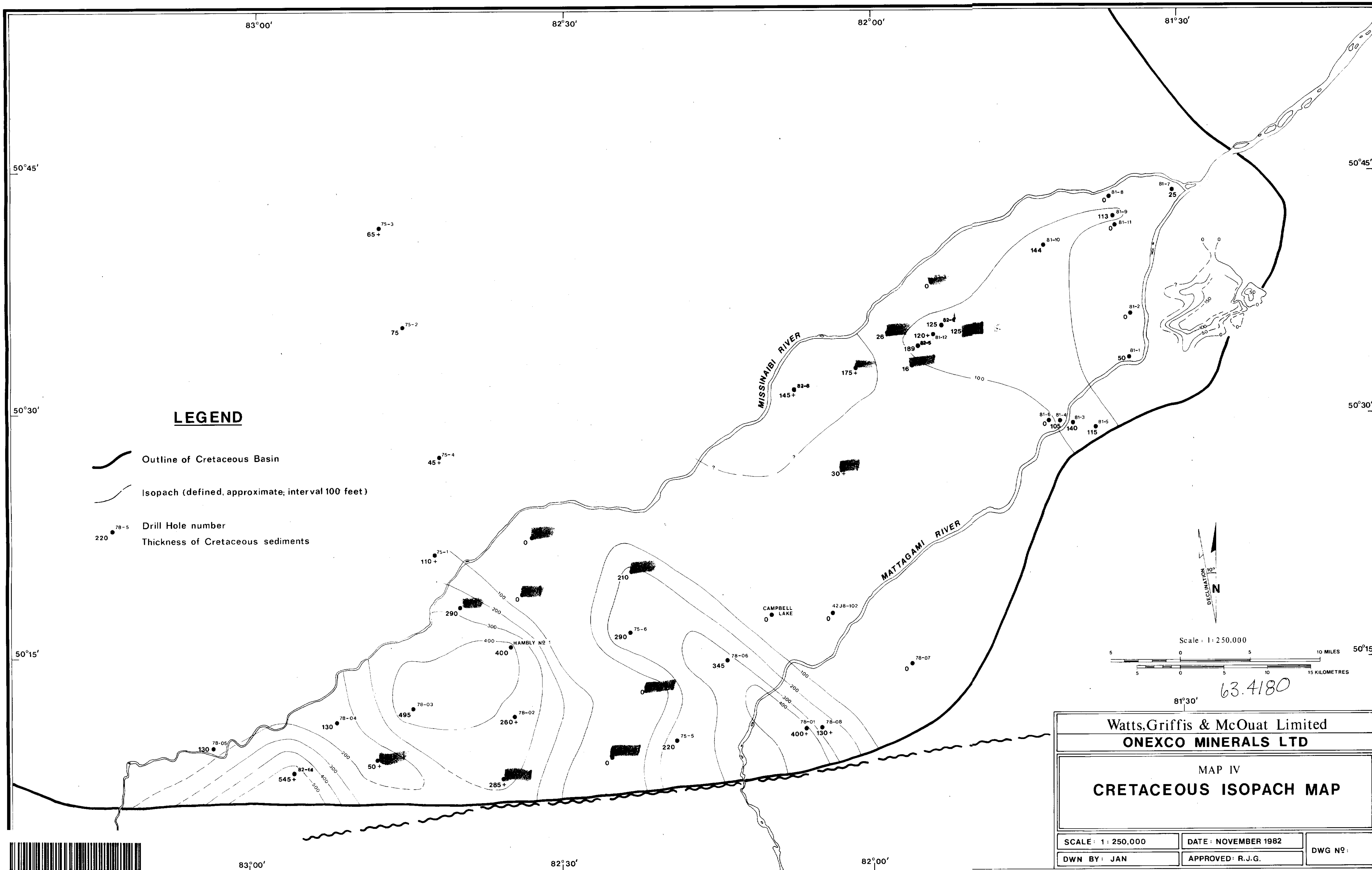
SCALE: AS SHOWN		APPROVED: R.J.G.
DRAFTING: FIONA	DATE: NOVEMBER 1982	PROJECT Nº 618-1 DWG Nº 11

42J08NE0001 63.4180 LAMBERT

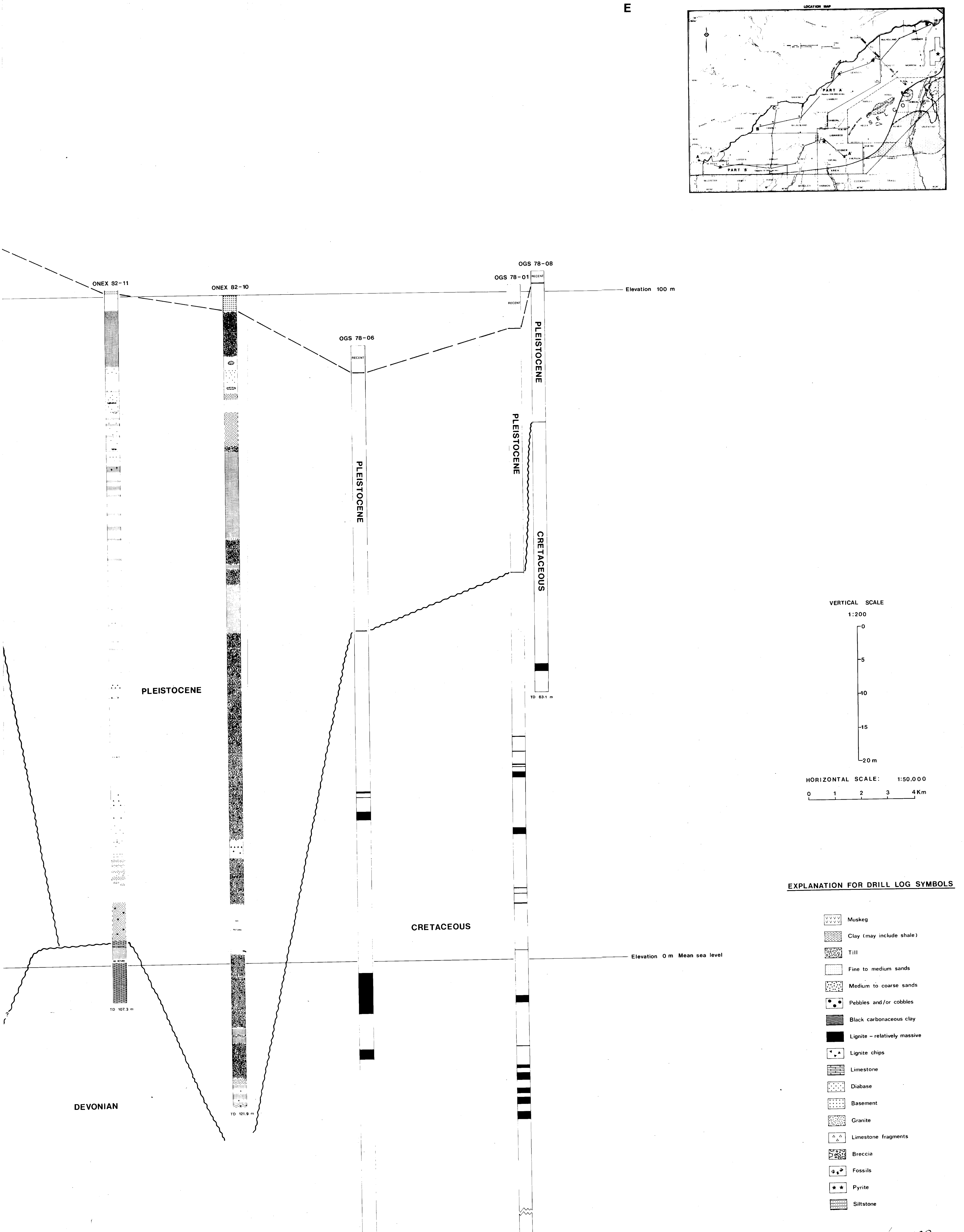
210

42J08NE0001 63.4180 LAMBERT

220



42J08NE0001 63.4180 LAMBERT



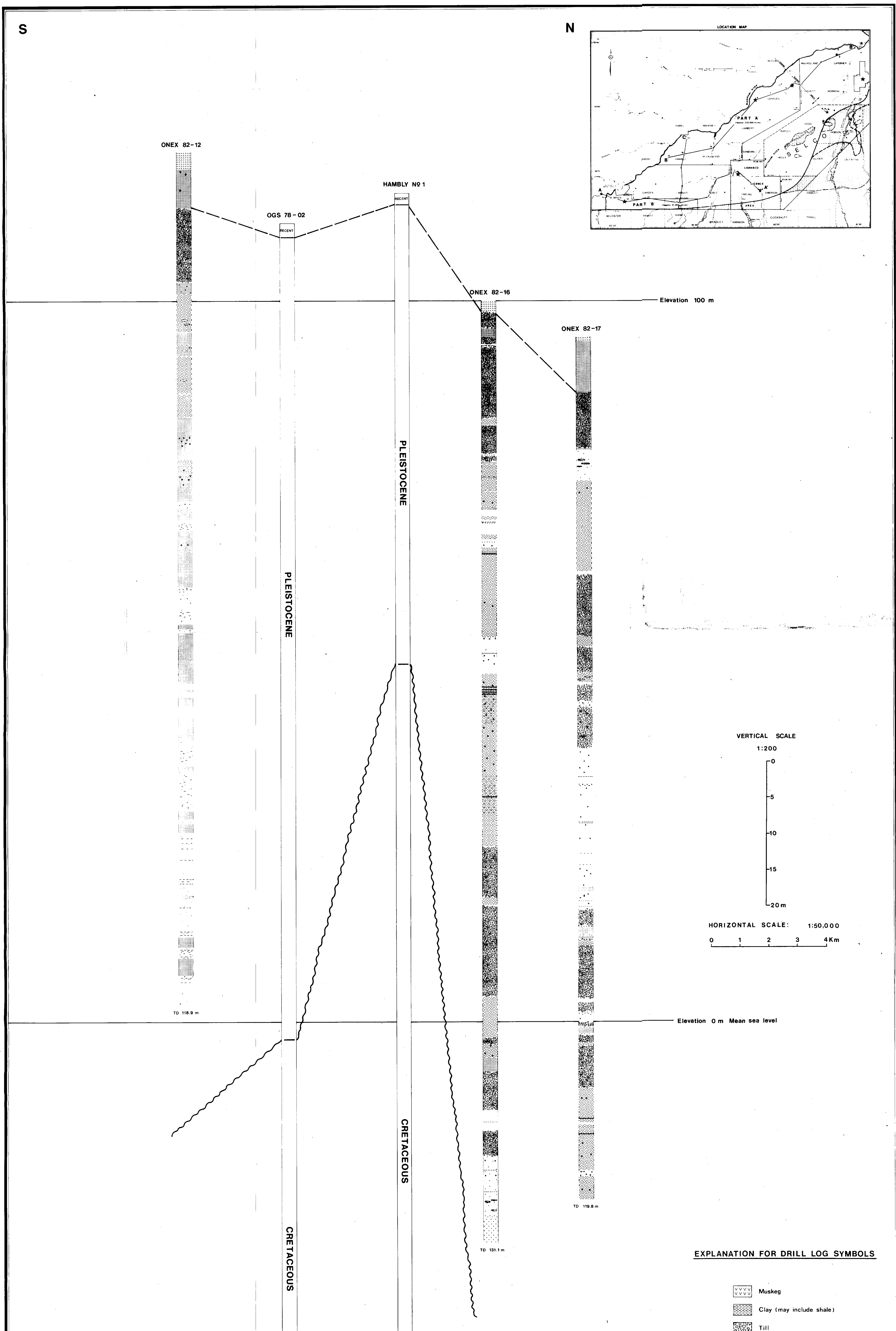
63.4180

Watts, Griffis & McOuat Limited
ONEXCO MINERALS LTD

GEOLOGICAL CROSS SECTION A-A'
JAMES BAY LOWLAND

SCALE AS SHOWN		APPROVED R.J.G.
DRAFTING JAN. FIONA	DATE NOVEMBER 1982	PROJECT Nº 518-1 DWG Nº

NE
LOCATION MAP
PART A
PART B
Elevation 100 m
EXPLANATION FOR DRILL LOG SYMBOLS
Muskeg
Clay (may include shale)
Till
Fine to medium sands
Medium to coarse sands
Pebbles and/or cobbles
Black carbonaceous clay
Lignite - relatively massive
Lignite chips
Limestone
Diabase
Basement
Granite
Limestone fragments
Breccia
Fossils
Pyrite
Siltstone
ONEX 82-8
ONEX 82-7
ONEX 82-5
OEC 81-12
ONEX 82-6
ONEX 82-2
OEC 81-10
OEC 81-9
OEC 81-7
RECENT
PLEISTOCENE
CRETACEOUS
DEVONIAN
LONG RAPIDS Fm
WILLIAMS ISLAND Fm
Elevation 0 m Mean sea level
TD 130.5 m
TD 122.7 m
TD 133.8 m
TD 87.8 m
TD 140.2 m
TD 98.2 m
TD 98.3 m
TD 92.5 m
TD 71.8 m
VERTICAL SCALE
1:200
0
5
10
15
20 m
HORIZONTAL SCALE: 1:50,000
0 1 2 3 4 Km
63.4180
Watts, Griffis & McOuat Limited
ONEXCO MINERALS LTD
GEOLOGICAL CROSS SECTION B-B'
JAMES BAY LOWLAND
SCALE AS SHOWN
APPROVED R.J.G.
DRAFTING JAN. FIONA
DATE NOVEMBER 1982
PROJECT NO. 618-1
DWG NO.



EXPLANATION FOR DRILL LOG SYMBOLS

- Muskeg
- Clay (may include shale)
- Till
- Fine to medium sands
- Medium to coarse sands
- Pebbles and/or cobbles
- Black carbonaceous clay
- Lignite - relatively massive
- Lignite chips
- Limestone
- Diabase
- Basement
- Granite
- Limestone fragments
- Breccia
- Fossils
- Pyrite
- Siltstone

63.4180

Watts, Griffis & McOuat Limited

ONEXCO MINERALS LTD

GEOLOGICAL CROSS SECTION C-C'
JAMES BAY LOWLAND

SCALE AS SHOWN		APPROVED R.J.G.
DRAFTING JAN. FIONA	DATE NOVEMBER 1982	PROJECT Nº 618-1 DWG Nº

COMPU-LOG V8L2 PLOT 08-08-82

82-1

ONEXCO MINERALS LTD.

E.CENTRAL GENTLES TP

HOLE DIAMETER : 08.0
PROBE # 9067 - 520
SENSOR #2 CAL STD CPS = 166
SENSOR #2 CAL RUN CPS = 86
SENSOR #2 CAL BIAS = 1
DATA V8L2WA TRUCK # 81-2
M.R.GARIN APPL.#1007L1

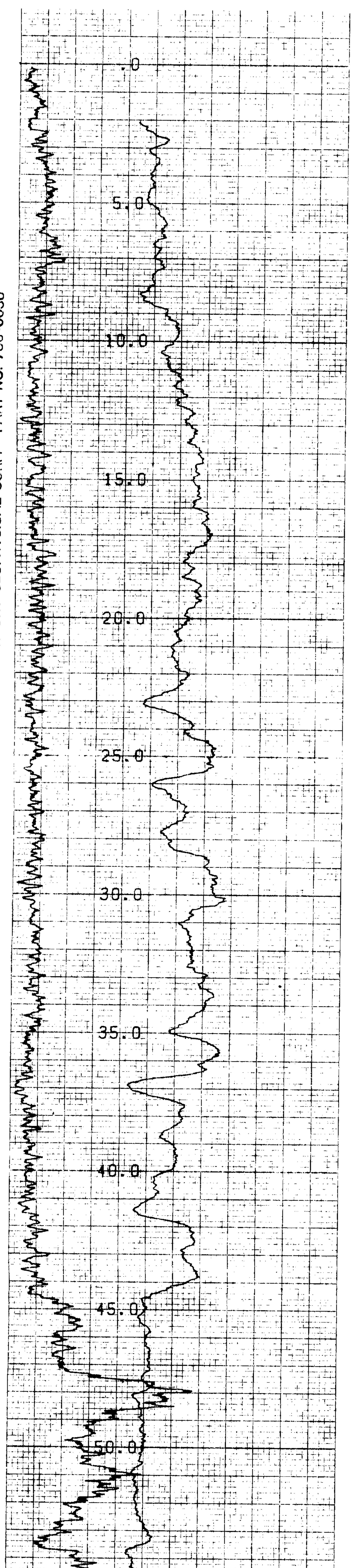
COMPU-LOG V8L2 PLOT 08-08-82

82-1

ONEXCO MINERALS LTD.

E.CENTRAL GENTLES TP

HOLE DIAMETER : 08.0
PROBE # 9060 - 644
SENSOR #2 CAL STD CPS = 2283
SENSOR #2 CAL RUN CPS = 9206
SENSOR #2 CAL BIAS = 0
DATA V8L2WA TRUCK # 81-2
M.R.GARIN APPL.#3010L1



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35.0
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45.0
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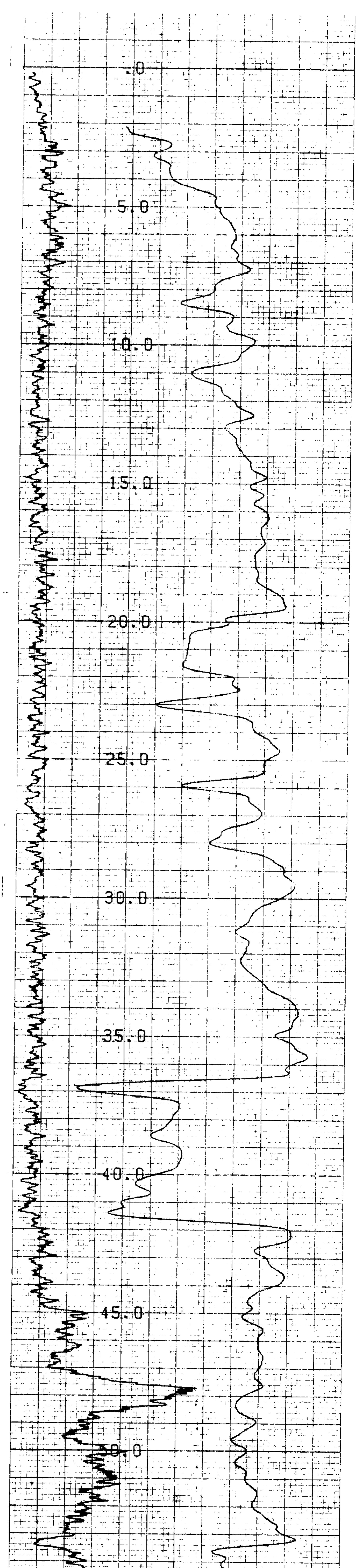
55.0
57.9
GAMMA API
N-N CPS
82-2
ONEXCO MINERALS LTD.
CENTRAL PICKETT TP



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55.0
57.9
GAMMA API
G-G LNCPS
82-2
ONEXCO MINERALS LTD.
CENTRAL PICKETT TP

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60.0
65.0
70.0
75.0
80.0
83.2
83.3
-300
1200
N-N CPS
0.0
G-G LNCPS
COMPU-LOG VOL2 PLOT 08-10-82
82-3
ONEXCO MINERLS LTD.
S.E. MCCUAIG TP
82-3
ONEXCO MINERALS LTD.
S.E. MCCUAIG TP

COMPU-LOG YBL2 PLOT 09-10-82

82-4
ONEXCO MINERALS LTD.
CENTRAL GENTLES TP

HOLE DIAMETER : 05.0
PROBE # 8083 - 528
SENSOR #3 CAL STD CPS = 166
SENSOR #2 CAL RUN CPS = 86
SENSOR #2 CAL BIAS = 0
DATA YBL3 TRUCK # 81-2
H.R.BRAIN APPL.#3007L1

COMPU-LOG YBL2 PLOT 09-10-82

82-4
ONEXCO MINERALS LTD.
CENTRAL GENTLES TP

HOLE DIAMETER : 05.0
PROBE # 9068 - 644
SENSOR #2 CAL STD CPS = 2283
SENSOR #2 CAL RUN CPS = 8286
SENSOR #2 CAL BIAS = 0
DATA YBL22 TRUCK # 81-2
H.R.BRAIN APPL.#3018L1

CENTURY GEOPHYSICAL CORP. PART NO. 786-0038

300

42J08NE0001 63.4180 LAMBERT

COMPU-LOG V8L2 PLOT 08-08-82

82-6
ONEXCO MINERALS LTD.
W. CENTRAL PICKETT TP

COMPU-LOG V8L2 PLOT 09-08-82

82-6
ONEXCO MINERALS LTD.
W. CENTRAL PICKETT TP

CENTURY GEOPHYSICAL CORP. PART NO. 736-0038

320

CENTURY GEOPHYSICAL CORP. PART NO. 786-0038

COMPU-LOG VBL2 PLOT 08-10-82

82-7
ONEXCO MINERALS LTD.
CENTRAL GENTLES TP

HOLE DIAMETER : 03.0
PROBE # 8067 - 828
SENSOR #2 CAL STD CPS = 166
SENSOR #2 CAL RUN CPS = 86
SENSOR #2 CAL BIAS = 0
DATA VBL23 TRUCK # 81-2
M.R.GRAIN APPL.#1007L1

COMPU-LOG VBL2 PLOT 08-10-82

82-7
ONEXCO MINERALS LTD.
CENTRAL GENTLES TP

HOLE DIAMETER : 03.0
PROBE # 8068 - 844
SENSOR #2 CAL STD CPS = 2283
SENSOR #2 CAL RUN CPS = 8286
SENSOR #2 CAL BIAS = 0
DATA VBL2 TRUCK # 81-2
M.R.GRAIN APPL.#3010L1


CENTURY GEOPHYSICAL CORP. PART NO. 786-0038
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75.0
80.0
85.0
90.0
95.0
100.0
105.0
110.0
115.0
120.0
125.0
126.3
126.4
GAMMA API
N-N CPS
960
-300
1200
8.8
7.8
COMPU-LOG VOL3 PLOT 08-10-82
82-8
ONEXCO MINERALS LTD.
W. OF GENTLES TP
HOLE DIAMETER : 08.0
SENSOR #2 CAL STD CPS = 2283
SENSOR #2 CAL RUN CPS = 0286
SENSOR #2 CAL BIAS = 0
DATA VOL20
TRUCK # 81-2

CENTURY GEOPHYSICAL CORP. PART NO. 786-0038
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85.0
90.0
95.0
98.2
98.4
GAMMA API
N-N CPS
G-G LNCPS
-300
1700
960
COMPU-LOG VOL2 PLOT 09-15-82
82-10
ONEXCO MINERALS LTD.
N.CENTRAL WRIGHT TWP
HOLE DIAMETER : 06.0
SENSOR #2 CAL BIAS = 0
TRUCK # 81-2


CENTURY GEOPHYSICAL CORP. PART NO. 786-0038
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45.0
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55.0
60.0
65.0
70.0
75.0
80.0
82.7
82.6
GAMMA API
82-11
ONEXCO MINERALS LTD.
S.W.1/4 WRIGHT TWP
82-11
ONEXCO MINERALS LTD.
S.W.1/4 WRIGHT TWP


CENTURY GEOPHYSICAL CORP. PART NO. 786-0038
.0
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30.0
35.0
40.0
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105.0
109.9
110.1
0
960
GAMMA API
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1200
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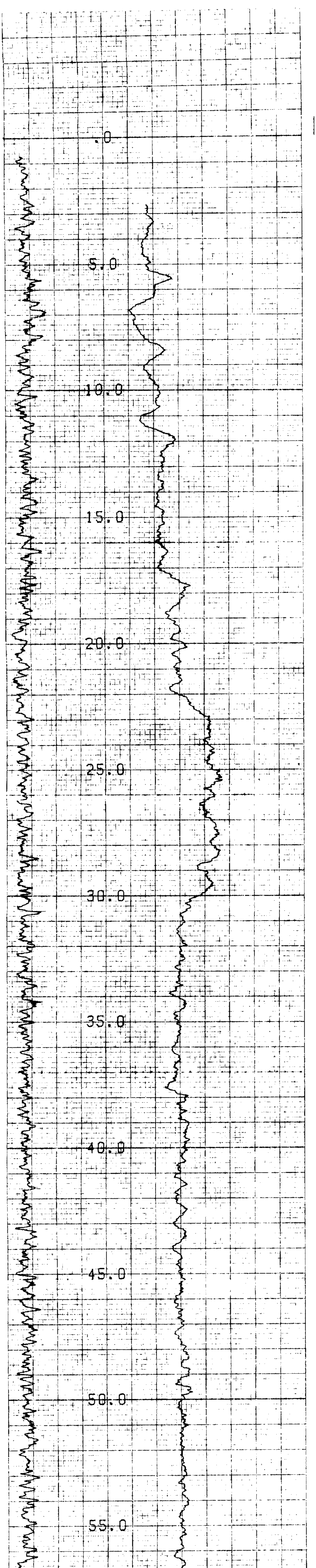
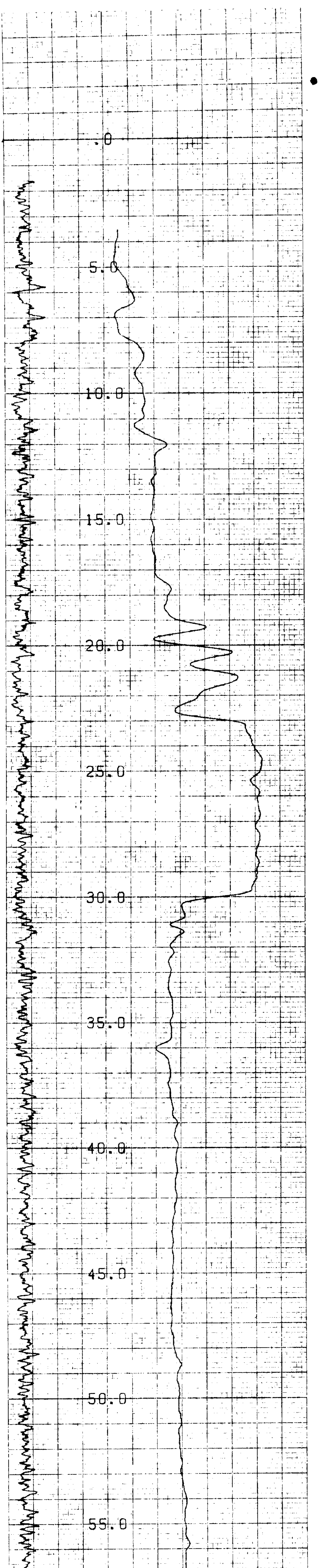
G-G LNCPS
82-12
ONEXCO MINERALS LTD.
S.CENTRAL WRIGHT TWP
TRUCK # 01-2





COMPU-LOG V0L2 PLOT 08-14-82

82-13

ONEXCO MINERALS LTD.

CENTRAL GARDEN TWP

HOLE DIAMETER : 05.0
PROBE # 0067 - 020
SENSOR #2 CAL STD CPS = 160
SENSOR #2 CAL RUN CPS = 86
SENSOR #2 CAL BIAS = 0
DATA V0L2WA TRUCK # 01-2
M.R.BRAIN APPL.0100YL1

COMPU-LOG V0L2 PLOT 08-14-82

82-13

ONEXCO MINERALS LTD.

CENTRAL GARDEN TWP

HOLE DIAMETER : 05.0
PROBE # 0068 - 044
SENSOR #2 CAL STD CPS = 2203
SENSOR #2 CAL RUN CPS = 8286
SENSOR #2 CAL BIAS = 0
DATA V0L2 TRUCK # 01-2
M.R.BRAIN APPL.0001GL1

COMPU-LOG VAL2 PLOT 08-14-82
82-14
ONEXCO MINERALS LTD.
S.E.1/4 MCBRIEN TWP
HOLE DIAMETER : 06.0
PROBE # 8007 - 020
SENSOR #2 CAL STD CPS = 180
SENSOR #2 CAL RUN CPS = 80
SENSOR #2 CAL BIAS = 0
DATA VAL2 TRUCK # 81-2
H.R.GRAIN APPL.#2007L1

COMPU-LOG VAL2 PLOT 08-14-82
82-14
ONEXCO MINERALS LTD.
S.E.1/4 MCBRIEN TWP
HOLE DIAMETER : 06.0
PROBE # 8008 - 044
SENSOR #2 CAL STD CPS = 2283
SENSOR #2 CAL RUN CPS = 0206
SENSOR #2 CAL BIAS = 0
DATA VAL2U TRUCK # 81-2
H.R.GRAIN APPL.#3010L1

CENTURY GEOPHYSICAL CORP. PART NO. 786-0038

COMPU-LOG VOL2 PLOT 08-14-82

82-15
ONEXCO MINERALS LTD.
W.CENTRAL HAMBLY TWP

HOLE DIAMETER : 05.0
PROBE # 0067 — 525
SENSOR #2 CAL STD CPS = 166
SENSOR #2 CAL RUN CPS = 86
SENSOR #2 CAL BIAS = 0
DATA VOL2TS TRUCK # 01-2
M.R.BRAIN APPL.#1007L1

COMPU-LOG VOL2 PLOT 08-14-82

82-15
ONEXCO MINERALS LTD
W.CENTRAL HAMBLY TWP

HOLE DIAMETER : 05.0
PROBE # 9060 — 644
SENSOR #2 CAL STD CPS = 2283
SENSOR #2 CAL RUN CPS = 0286
SENSOR #2 CAL BIAS = 0
DATA VOL2 TRUCK # 01-2
M.R.BRAIN APPL.#3010L1


CENTURY GEOPHYSICAL CORP. PART NO. 786-0038
105.9
GAMMA API
N-N CPS
106.3
GAMMA API
G-G LNCPS
82-16
ONEXCO MINERALS LTD.
CENTRAL HAMBLY TWP
82-16
ONEXCO MINERALS LTD.
CENTRAL HAMBLY TWP

COMPU-LOG VAL2 PLOT 08-11-82

82-17

ONEXCO MINERALS LTD.

S.E. 1/4 OF HABEL TWP

HOLE DIAMETER = 08.0
PROBE # 9007 - 326
SENSOR #2 CAL STD CPS = 186
SENSOR #2 CAL RUN CPS = 86
SENSOR #2 CAL BIAS = 0
DATA VAL2 TRUCK # 81-2
M.R.BRAIN APPL.#1007L1

COMPU-LOG VAL2 PLOT 08-11-82

82-17

ONEXCO MINERALS LTD.

S.E. 1/4 OF HABEL TP

HOLE DIAMETER = 05.0
PROBE # 9008 - 844
SENSOR #2 CAL STD CPS = 2283
SENSOR #2 CAL RUN CPS = 8286
SENSOR #2 CAL BIAS = 0
DATA VAL2UU TRUCK # 81-2
M.R.BRAIN APPL.#001BL1

COMPU-LOG VGL2 PLOT 08-11-82

82-18

DNEXCO MINERALS LTD.

N.CENTRAL MCCAUSLAND

HOLE DIAMETER : 06.0

PROBE # 8067 - 520

SENSOR #2 CAL STD CPS = 166

SENSOR #2 CAL RUN CPS = 86

SENSOR #2 CAL BIAS = 0

DATA VGL2 TRUCK # 81-2

M.A.BRAIN APPL.#1007L1

COMPU-LOG VGL2 PLOT 08-11-82

82-18

DNEXCO MINERALS LTD.

N.CENTRAL MCCAUSLAND

HOLE DIAMETER : 06.0

PROBE # 8068 - 544

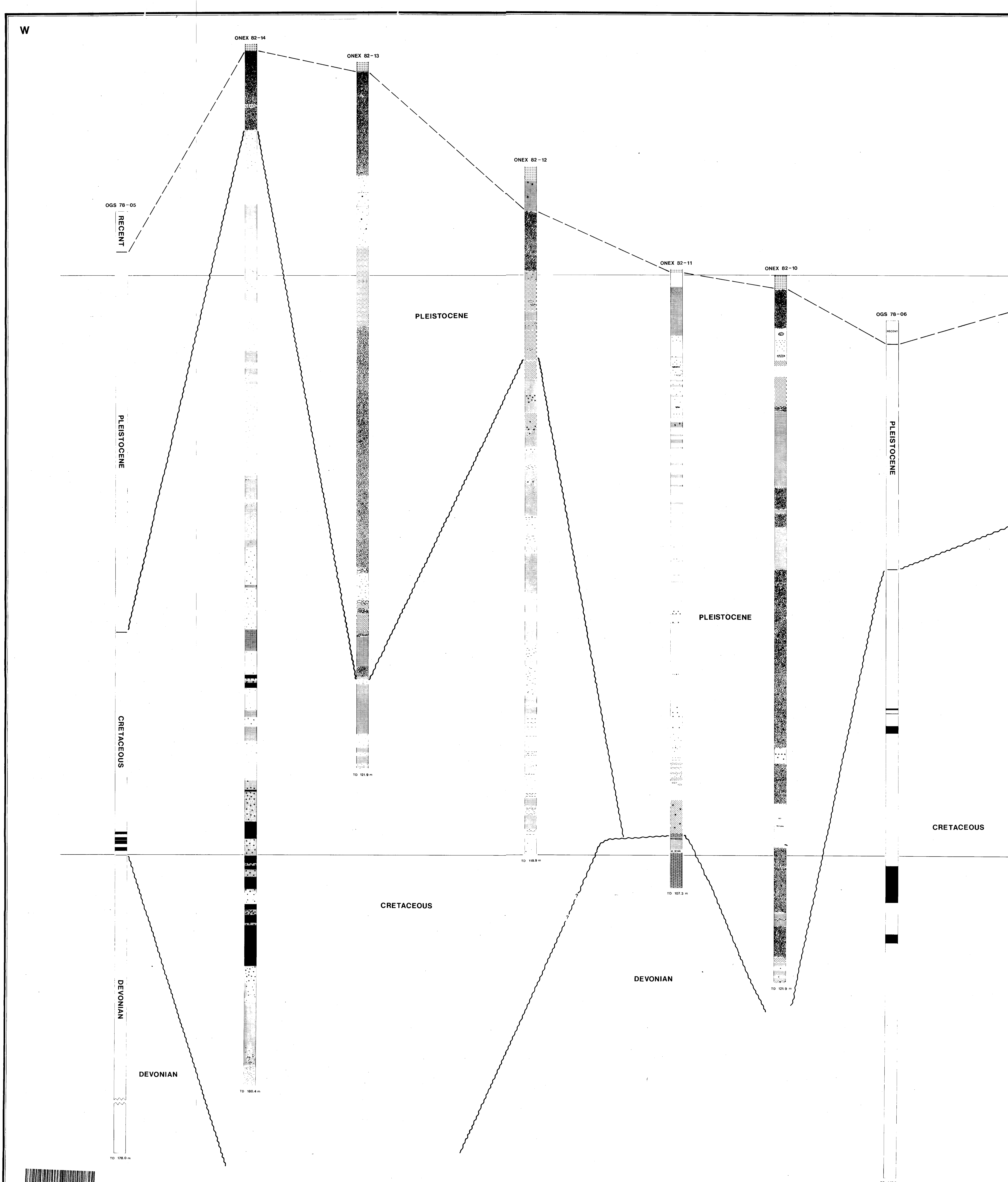
SENSOR #2 CAL STD CPS = 2283

SENSOR #2 CAL RUN CPS = 8286

SENSOR #2 CAL BIAS = 0

DATA VGL26 TRUCK # 81-2

M.A.BRAIN APPL.#3010L1



W
ONEX 82-14
ONEX 82-13
ONEX 82-12
ONEX 82-11
ONEX 82-10
OGS 78-05
OGS 78-06
RECENT
PLEISTOCENE
CRETACEOUS
DEVONIAN
PLEISTOCENE
PLEISTOCENE
PLEISTOCENE
CRETACEOUS
CRETACEOUS
DEVONIAN
DEVONIAN
RECENT
TD 121.9 m
TD 118.9 m
TD 107.3 m
TD 121.9 m
TD 180.4 m
TD 178.0 m
TD 147.0 m

SW
ONEX 82-15
ONEX 82-16
ONEX 82-18
ONEX 82-8
ONEX 82-7
PLEISTOCENE
PLEISTOCENE
CRETACEOUS
CRETACEOUS
DEVONIAN
LONG RAPIDS Fm
DEVONIAN
LONG RAPIDS Fm
DEVONIA
LONG RAPIDS
TD 133.2 m
TD 131.1 m
TD 125.0 m
TD 130.5 m
TD 122.7 m