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Rotasonic Drilling Operations (1984) and Overburden Heavy Mineral Studies, Matheson Area, District of Cochrane

by

S.A. Averill, K.A. MacNeil, R.G. Huneault, and
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FORWARD

The sonic drilling program is a component of Operation Black River-Matheson (BRIM) a multi-disciplinary geoscientific study begun in 1982. The aim of the BRIM program, to stimulate mineral exploration, discovery and development, is well advanced by the reconnaissance overburden drilling described in this report. The report illustrates how the OGS applies modern technology to produce work of a high scientific calibre that sets the standard for other such studies. In the process of this work basic Quaternary stratigraphic, geochemical and geological information were produced. This will, in conjunction with future drilling results, provide a basis for exploration and data interpretation for the foreseeable future.

The BRIM drilling was jointly managed by the Geophysics/Geochemistry and Engineering and Terrain Geology Sections of the OGS. The contributions of these sections have lead to an integration of geoscientific disciplines. The Survey personnel involved have an understanding of the problems and needs of the exploration community, the ability to apply innovative solutions to answer them and the expertize to interpret data produced.

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued

Page

PLANS

FIGURES

PLATES

TABLES

ABSTRACT

The report describes drilling operations and heavy mineral studies for a 42-hole rotasonic program conducted on behalf of the Ontario Geological Survey in the Black River-Matheson area. Core logs, stratigraphic interpretations and geochemical data are presented in separate OGS publications.

Midwest Drilling of Winnipeg conducted an efficient drilling operation with productivity rates of 12.3 feet (3.7 m) per hour and only 4.6 percent down-time. Drilling costs, including 8 km (5.0 mile) average moves between holes, were $30.73 per foot ($100.83 per metre).

Bit penetration and core recovery were carefully monitored. Specific drilling techniques were developed to alleviate core losses in saturated gravels and other difficult formations, resulting in overall recovery rates of better than 90 percent.

Heavy mineral concentrates were prepared from till, sand and gravel samples. Sulphide concentrations are low and kimberlite indicator minerals appear to be absent. Gold grains were recovered from 40 percent of the samples.

ROTASONIC DRILLING OPERATIONS AND OVERBURDEN HEAVY MINERAL STUDIES, MATHESON AREA, DISTRICT OF COCHRANE

S.A. Averill[1], K.A., MacNeil[2], R.G. Huneault[2], and C.L. Baker[3]

1. INTRODUCTION

1.1 The Black River-Matheson Program

The overburden drilling that is discussed in this report was conducted in October-November, 1984, under the Black River-Matheson Program, hereinforth referred to as BRIM. The BRIM Program, is a series of geoscience studies commencing in 1982 and continuing for a period of seven years. It is funded jointly by the Ontario Ministry of Northern Development and Mines and the Ontario Ministry of Natural Resources and is managed by the Ontario Geological Survey (OGS).

The objective of BRIM is to stimulate exploration and development in the Black River-Matheson area. Direct stimulation is provided through the release of new geophysical and geochemical data and indirect stimulation

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is provided through research into regional parameters that influence interpretation of existing data. Gold exploration is being emphasized because the area has demonstrated a high potential for gold mineralization, but deposits of base metals and diamonds are also being sought.

BRIM involves the application of a variety of geoscientific techniques including mapping of the bedrock and surficial deposits, airborne geophysical surveys, overburden sampling and metallogenic studies. Individual surveys are conducted on an annual basis and data is released in Open File Report form for use by the mineral exploration industry.

1.2 BRIM Survey Area

The area to be covered by BRIM surveys surrounds the town of Matheson, 72 km east of Timmins, northeastern Ontario (Fig. 1). It forms a 39 x 97 km (24 x 60 mile) rectangle extending from the Timmins city limits (40 km from the city itself) in the west to the Quebec border in the east. The area comprises 36 surveyed townships plus unsubdivided lands under Lake Abitibi equivalent in size to four townships.

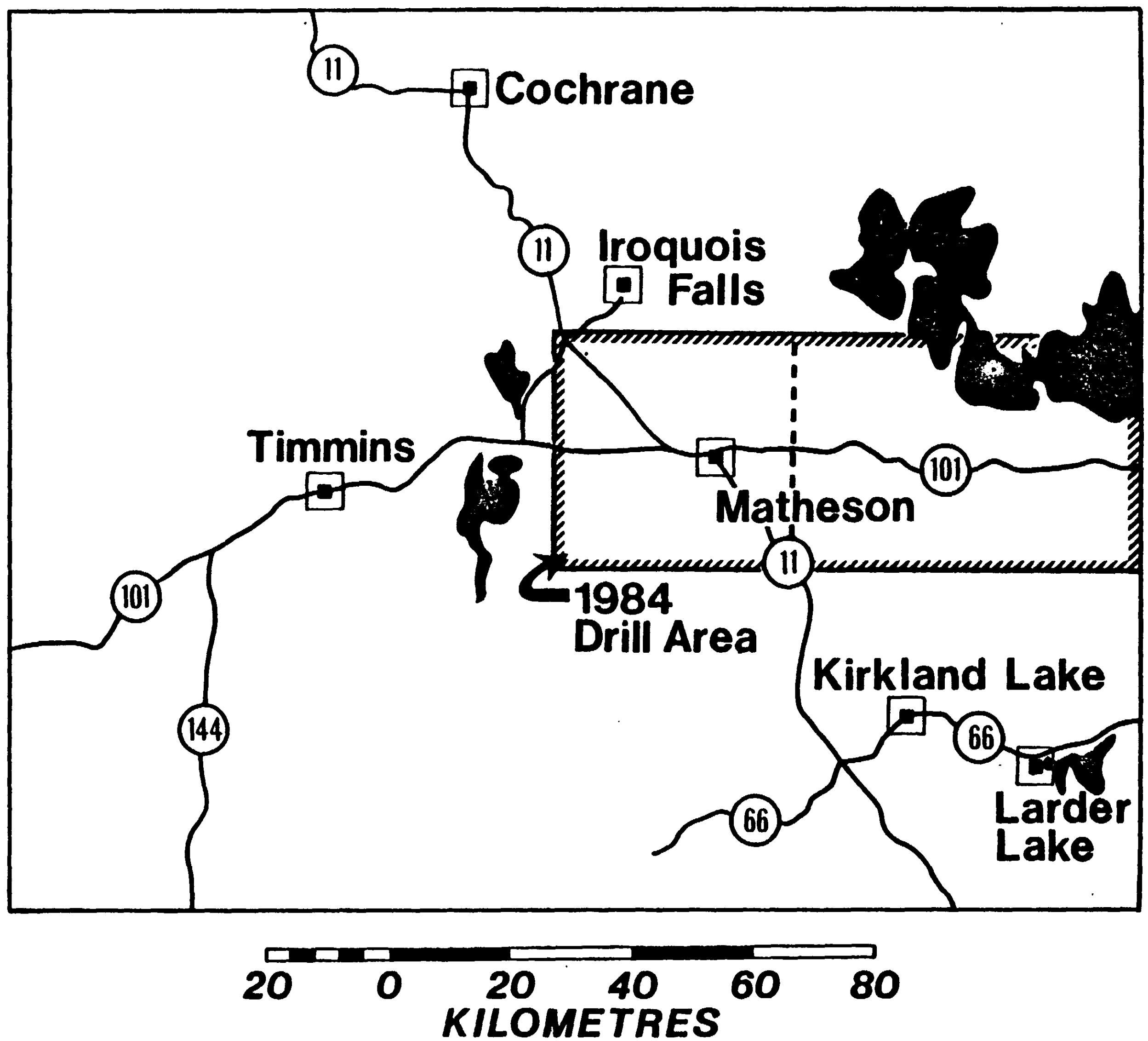


Figure 1 - BRIM Survey Area.

1.3 The 1984 Drill Area

The area selected for the 1984 drill program comprises a 4 x 4 township block (Fig. 2) at the western end of the BRIM project area. The townships in this block lie mainly within the boundaries of the Township of Black River-Matheson and the Town of Iroquois Falls. They are listed below, with the columns and rows indicating their relative north-south and east-west positions, respectively:

Clergue	**Walker**	Wilkie	Coulson
Stock	**Taylor**	**Carr**	**Beatty**
Bond	**Currie**	**Bowman**	**Hislop**
Sheraton	Egan	McCann	**Playfair**

Significant portions of those townships shown in bold type are in the agricultural part of the clay plain where access is excellent, and it is in these townships, with the exception of Clergue, that drilling was concentrated. Clergue Township was not drilled due to budget constraints. No drilling was done in Wilkie and Coulson Townships in the swampy northeastern part of the clay plain or in Sheraton and Egan Townships on the southern upland. Only one hole was drilled in McCann Township on the upland. The shallow overburden in the upland area is better suited to backhoe sampling, and a program of this type was undertaken by the OGS prior to the drill program.

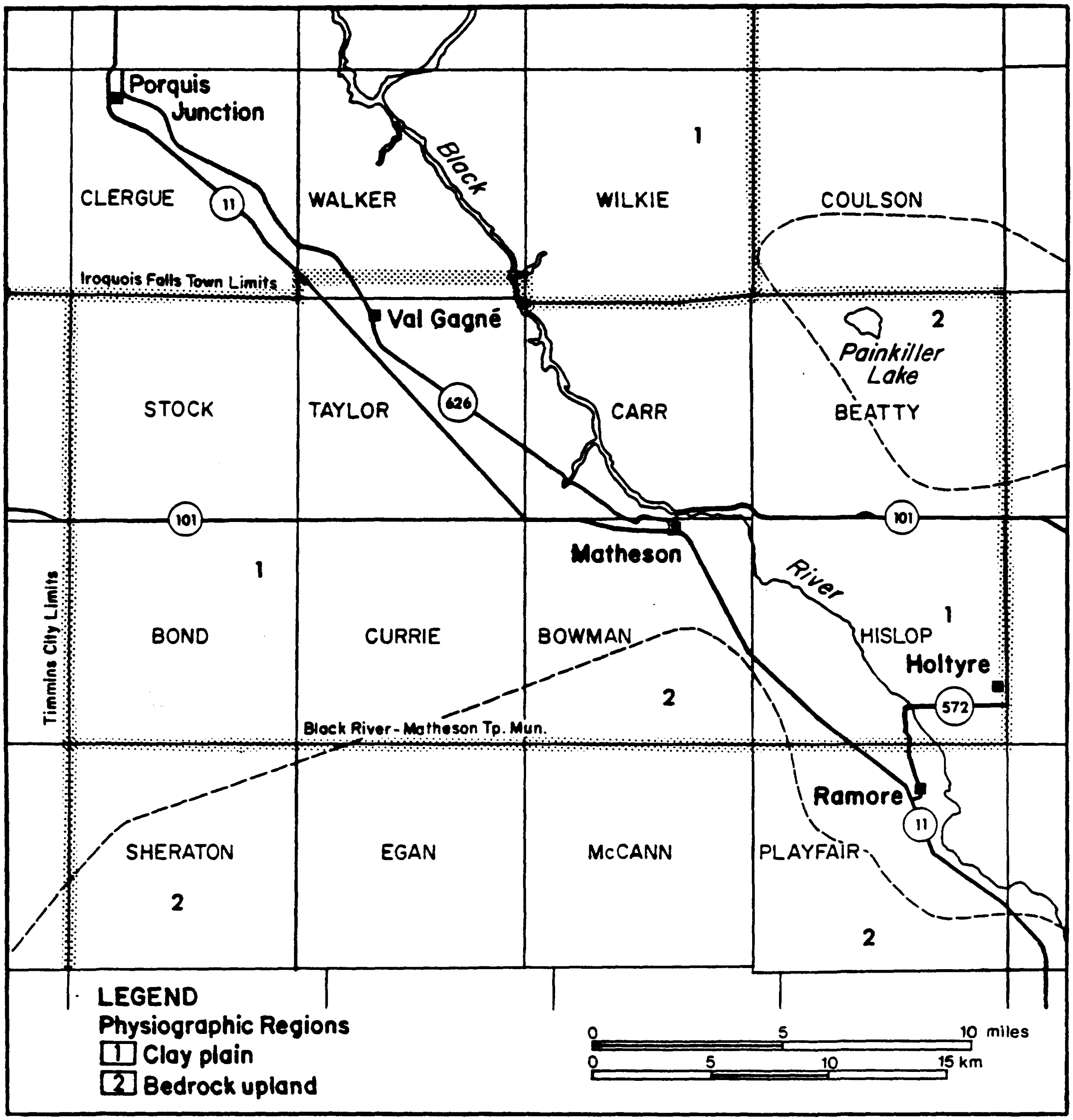


Figure 2 - Physiography of the 1984 Drill Area.

1.4 Physiography

The 1984 BRIM drill area is underlain by Archean metavolcanic, metasedimentary and associated intrusive rocks of the Abitibi greenstone belt. However, its physiography is controlled primarily by glacial geology rather than by bedrock geology.

The area lies immediately north of the continental drainage divide. It is divided diagonally into two main physiographic regions - a southern bedrock upland and a northwestern clay plain (Fig. 2). A second upland rises from the plain at Painkiller Lake in the northeast. Major southeast trending esker (glaciofluvial) ridges locally rise above both the plain and the uplands.

The clay plain was deposited as the bed of glacial Lakes Barlow and Ojibway during the last ice recession. These glacial lakes reached a maximum elevation of 1250 feet (381 m) (Baker *et al* 1982). Most upland valleys between bedrock knobs or esker ridges below this elevation are infilled with clay. The clay plain surface is at an average elevation of 900 feet (275 m) and is typically broken by several small, scattered outcrops per township. Elevations in the bedrock uplands and on the esker ridges are generally 1000-1200 feet (305-366 m).

1.5 Access

Matheson is located at the junction of two major road transportation routes - Ontario Highway 101 which passes eastward from Timmins across the clay plain en route to Quebec, and Trans-Canada Route 11 which parallels the Black River in a southeasterly direction across the clay plain.

The western part of the report area is well-drained clay plain and has been partially developed for beef and dairy farming. Excellent access is provided by secondary township roads on a 1 mile x 1 mile (1.6 x 1.6 km) grid pattern. The northeastern part of the plain in Coulson and Wilkie Townships is poorly drained and access is by winter tractor roads. In the upland areas to the south and northeast, limited access is provided by a few timber haul roads and mining exploration trails. Only those haul roads that follow eskers are navigable by 2-wheel drive vehicles in summer.

1.6 Previous Work

Sustained mineral production in the drill area has been attained only at the Ross mine (gold) in Hislop Township. However, the important Archean metavolcanic/metasedimentary strata and structures (Pipestone and Destor-Porcupine Faults) of the Timmins gold camp pass through the area. Most of the townships have been mapped in detail and extensively prospected for gold and other metals. This work is summarized in two OGS regional maps (Pyke et al 1973; MERQ-OGS 1984). BRIM airborne magnetic/electromagnetic surveys of all townships were made in 1983 (OGS 1984).

Early regional mapping of the Quaternary surficial deposits was done by Hughes (1959, 1960) and Boissonneau (1965). Baker et al (1980), Vagners (1985) and Richard and McClenaghan (1985 a,b) have recently completed more detailed surficial mapping programs in the southeastern, northeastern and western sectors, respectively, of the 1984 drill area. Vincent and Hardy (1979) have proposed an evolutionary history of glacial lakes Barlow and Ojibway.

1.7 Scope of the Report

Overburden Drilling Management Limited (ODM) of Nepean, Ontario, was retained by the OGS to manage the drilling operations and to prepare and log heavy mineral concentrates from Quaternary till, sand and gravel samples. OGS personnel logged and sampled the Quaternary and bedrock drill cores. The present report focusses on ODM's work, and only brief reference is made to Quaternary and bedrock stratigraphy.

Acknowledgements

We wish to acknowledge the friendly co-operation and assistance of many residents, businesses, and municipal officials of the Township of Black River-Matheson and the Town of Iroquois Falls. A. Baragar and R. Peever expedited permits for drilling on township roads. Several residents granted access to critical drill sites on their lands. We hope that everyone will benefit from the increased exploration activity generated by the BRIM program.

2. FIELD OPERATIONS

2.1 The Principles of Overburden Exploration in Glaciated Terrain

During the Pleistocene epoch of the Quaternary period, the crowns of all ore bodies that subcropped beneath the continental ice sheets of North America were eroded and dispersed down-ice in the glacial debris. The dispersion mechanisms were systematic (Averill 1978) and the resulting ore "trains" in the overburden are generally long, thin and narrow and most importantly are several times larger than the parent ore bodies. These large trains can be used very effectively to locate the remaining portion of the ore bodies.

Because the dispersion trains originated at the base of the ice, they are either partly or entirely buried by younger, nonanomalous glacial debris. Most trains are confined to a glacially deposited layer of debris, till, laid down during ice cover. In fact, the sampling of glacial overburden for exploration purposes is commonly referred to as "till sampling". The till in the Abitibi area is usually at the base of the Quaternary sediments, overlying bedrock. It is important to note, however, that in areas affected by multiple glaciations the bottom layer of debris in the overburden section may be only the lowermost of several stacked tills, and that a dispersion train may occur at any level within any one of the till horizons. Consequently, "till sampling" is not synonymous with the collection of samples from the base of the overburden section. Moreover, the term is not strictly correct because significant glacial dispersion trains can occur in deposits other than till.

From the foregoing statements, it can be seen that glacial dispersion and glacial stratigraphy are interdependent. Consequently, the effectiveness of overburden sampling as an exploration method is related to the ability of the sampling equipment to deliver stratigraphic information from the unconsolidated glacial deposits. In areas of deep overburden, drills must be used. Most drills have been designed to sample bedrock and are unsuitble for overburden exploration, but in the last fifteen years rotasonic coring rigs and reverse circulation rotary rigs have been developed to sample the overburden as well as the bedrock. Both drills deliver large samples that compensate for the natural inhomogeneity of glacial debris, and the rotasonic drills in particular provide accurate stratigraphic information throughout the hole. In overburden programs, both the overburden and bedrock are sampled. The bedrock samples are used to determine overburden provenance (and, hence, the precise directions of glacial transport) and the inter-related bedrock and overburden data provide exceptionally comprehensive exploration coverage.

Most of the glacial overburden in Canada is fresh, and metals in the overburden occur in primary, mechanically dispersed minerals, rather than in secondary chemical concentrations. While ore mineral dispersion trains are very large, they are also weak due to dilution by glacial transport and are difficult to identify from a normal "soil" analysis of the fine fraction of the samples. Consequently, heavy mineral concentrates are prepared to amplify the primary anomalies, and analysis of the fines is normally reserved for areas where significant hydromorphic remobilization has taken place or post-glacial oxidation is evident. The heavy mineral concentrates are very sensitive, and special care must be taken to avoid the introduction of contaminants into the samples. On gold exploration programs, it is advantageous to separate and examine any free gold particles because most gold anomalies in heavy mineral concentrates are caused by background nugget grains that are of limited interest.

2.2 Site Selection

Site selection of the 1984 sonic drill holes was accomplished by evaluation and assessment of a number of parameters. It was an aim of the BRIM till sampling program to have as even a distribution of sites across the area as was possible. The drill hole spacing was, therefore, influenced by the distribution of till samples obtained from backhoe trenching in areas of shallow overburden.

The reconnaissance nature of the drill program combined with budgetary constraints also dictated that the hole locations be positioned adjacent to roads capable of supporting the drill rig and accompanying support vehicles.

In an attempt to intersect the most complete Quaternary sections several holes were sited over east-west trending bedrock valleys. It was anticipated that by drilling over such valleys sediments older than those associated with the most recent glaciation might be encountered. It was felt that the orientation and shape of these valleys may have helped protect older materials from erosion by the last, southward flowing, ice mass.

The bedrock valleys were geophysically defined using data obtained by the BRIM airborne electromagnetic - magnetic survey (OGS 1984). It was reasoned that these valleys would be characterized by a thickening of the glaciolacustrine clay. The conductive nature of the clay allowed its distribution and thickness to be determined semi-quantitatively from the EM data. The procedure the OGS followed is given in Pitcher _et al_ (1984). This may be summarized as:

1) calculate the Channel 1 - Channel 2 difference parameter (DP) from the INPUT® system, thus screening bedrock conductors and cultural anomalies;
2) apply a low-pass filter to the DP;
3) contour the filtered DP.

Once contoured the east-west trending zones of high conductivity (thick clay) which crossed roads were considered as possible drill sites. The contour DP map was used in conjunction with surficial geology maps as eskers and sand plains appeared as low conductivity zones with the equally highly resistivity areas of outcrop and shallow drift. To overcome this the position of bedrock valleys was extrapolated from the clay plain to areas of sand cover hence suggesting additional drill sites.

Another factor taken into account in the selection of holes was the position of the two major fault zones which transect the area; the Destor-Porcupine and the Pipestone. Holes were drilled south of both of these to determine what, if any, reflection these features have in the down-ice till.

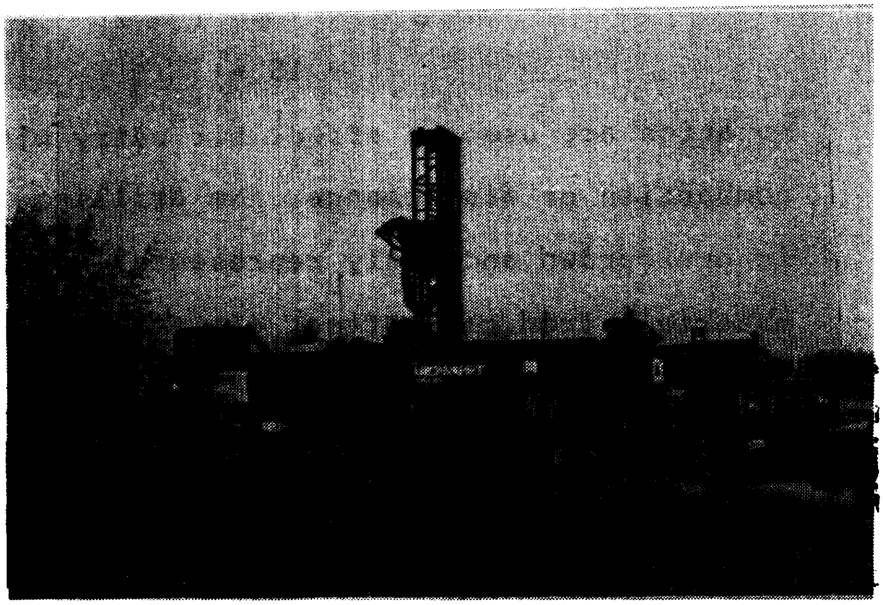
A number of the hole locations were chosen in consultation with geologists associated with other aspects of the BRIM program. These holes were drilled to resolve specific geological problems related to the distribution or structure of the Archean geology.

A constraint in the positioning of sites was the location and morphogy of eskers. No sites were positioned on esker crests as the likelihood of obtaining till was limited. However, two holes, 84-03 and 84-19, were drilled on sand plains adjacent to eskers with the latter encountering till at depth.

2.3 Drilling Equipment

The OGS chose the rotasonic coring method for the BRIM program as this allowed an undisturbed sample to be collected, detailed stratigraphy to be determined and library storage of unused material. The rotasonic coring method is based upon patents that were originally awarded to Dr. A.G. Bodine. Resonant vibrations and limited rotation are used to effect bit entry with minimum sample compaction or disturbance. No drilling fluid is required in overburden and truly representative cores of all materials from the softest clays to the hardest boulders and bedrock can be obtained.

Oscillator heads or "tubs" for rotasonic drills are manufactured by Hawker Siddeley Canada Limited. Midwest Drilling of Winnipeg has developed a practical overburden exploration drill rig (Plate 1) using the Hawker Siddeley head. A major feature of the rig is an efficient rod handling system that permits rapid casing insertion and core withdrawal after each 10 to 30 feet (3 to 9.1 m) of advance. The rod handling system involves a hydraulically operated dual rod/casing breakout/holding tool (Plate 2), an hydraulic tilting mechanism on the drill head (Plate 3) and a horizontal rod/casing storage bench. Midwest has also strengthened the rods and casing to withstand prolonged resonant vibrations, and has developed brass-free bit settings to prevent sample contamination on heavy mineral geochemical programs.



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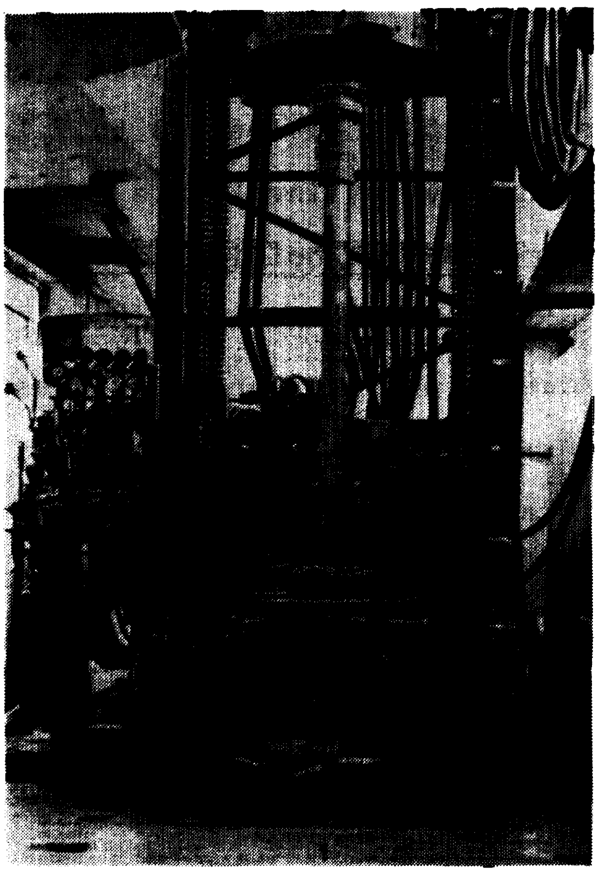

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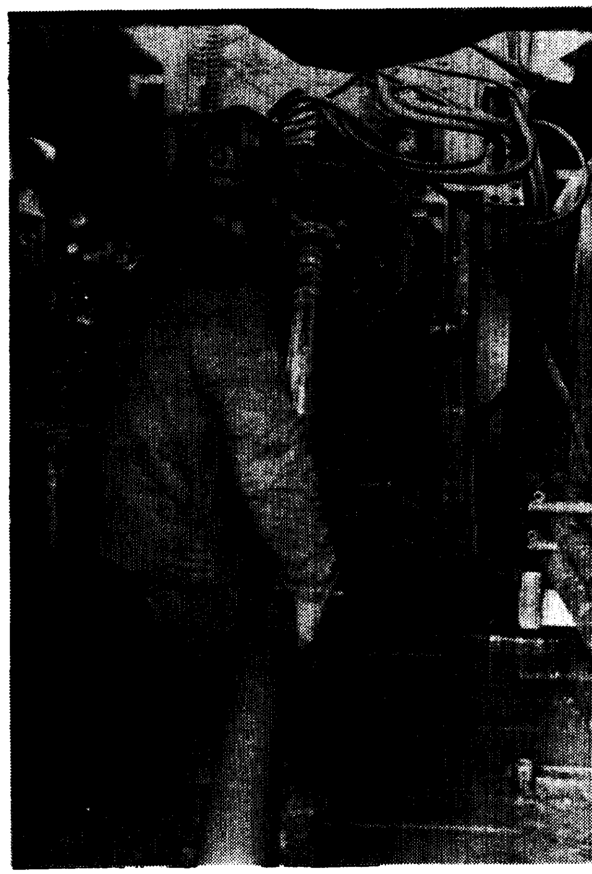

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Plate 1 - Skid drill at roadside site.

Plate 2 - Front view of drill tower showing footage index marks and hydraulic break-out tool.

Plate 3 - Removing core barrel with tub in tilted position.

The Midwest drill rig is variously mounted on a truck, skid or Nodwell tracked carrier, depending on terrain conditions. The three configurations were carefully considered in planning the BRIM program with its widely spaced holes and good road access. Truck mounting was rejected because it would not be possible to move a truck rig off the roadbed across the road ditches as required at most sites. Nodwell mounting was rejected because tracked rigs cannot travel on paved roads and rig height exceeds the allowable road limit when loaded on a low-bed truck. Skid mounting with full time low-bed truck support for moving between drill holes was therefore chosen.

Midwest's large skid drill for deep overburden conditions is 7.9 m long x 3 m wide x 3.4 m high (26' x 10' x 11') with the mast and tub in their horizontal transport mode. All functions are performed by hydraulic motors and cylinders connected to a central 210 horse power diesel engine. The drill rig weighs approximately 11.8 tonnes (13 tons). A lighter, gasoline-powered model is available for shallow overburden conditions.

A John Deere Model 640 log skidder was used to winch the drill skid on and off the low-bed (Plate 4), to clear brush from sites and to position the drill. The wheeled skidder was able to move between holes independently of the low-bed. Thus only one low-bed trip was required for each move.

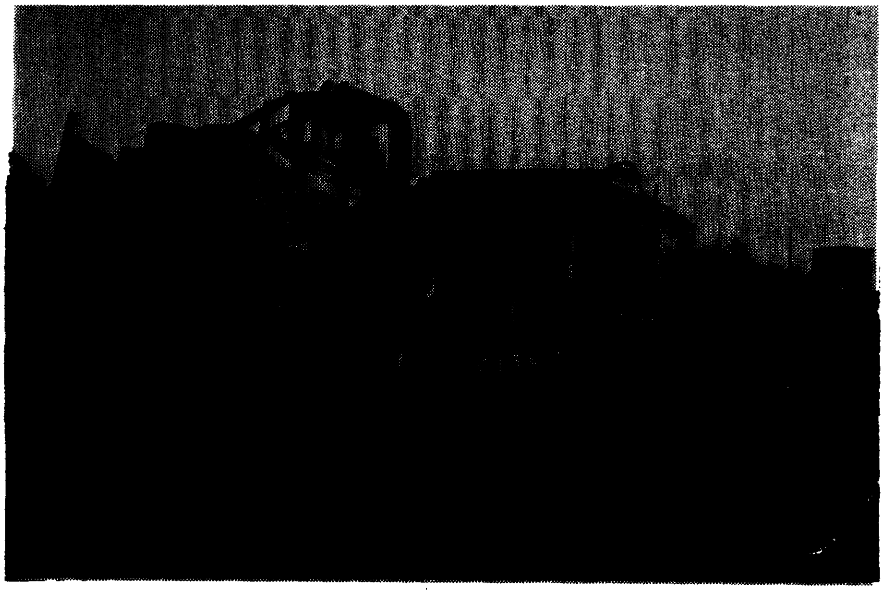

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Plate 4 - Skidder loading drill onto low-bed truck.
Plate 5 - Coring (left) and casing bits.

Midwest used a 3-ton truck to store spare rods and casing and to deliver water to the drill site. Water flushing is used during casing operations to prevent "sanding in" (seizing of the rods to the casing) but is not required for drilling except in large boulders or bedrock.

Midwest's coring bits are of the open shoe type and are faced with tungsten carbide buttons (Plate 5). The buttons are pressure set because brazed settings would cause Cu-Zn sample contamination. On the BRIM job, the coring string consisted of the following:

1. A 4.625 inch (11.75 cm) O.D. x 3.5 inch (8.89 cm) I.D. bit.
2. One to three 10 foot (3 m) long x 4.5 inch (11.43 cm) O.D. x 4.0 inch (10.16 cm) I.D. core barrels.
3. 10 foot (3 m) long x 3.5 inch (8.89 cm) O.D. x 2.375 inch (6.03 cm) I.D. extension rods.

The purpose of the small diameter of the extension rods relative to that of the core barrels is to reduce weight and improve rod handling efficiency. However, the rods must not be driven below the casing because caving at the shoulder of the core barrel would prevent withdrawal. Ten, five and two-foot (3, 1.5 and 0.6 m) casing sections of 5.5 inch (13.97 cm) O.D. x 4.75 inch (12.07 cm) I.D. were used. The casing shoes were similar in design to the coring bits (Plate 5).

The drilling equipment was carefully inspected prior to start-up to eliminate potential sources of sample contamination. Midwest had used no pipe thread sealents, a potential source of lead and copper, in the water circulation system. Three new brass shut-off valves had been installed on the water pump and the hose lines were flushed to remove suspected brass filings. All rod and casing threads were steam cleaned to remove old grease of unknown composition. Only Esso Unitol grease of the following composition was allowed on the job:

ppm				
Cu	Pb	Zn	Ni	Mo
Nil	18	3,740	7	2

The Zn content of Unitol is rather high but the Zn is not in metallic form and therefore will not affect heavy mineral analyses. Unitol is bright blue and highly visible. Thus Zn contamination can be avoided in a whole sample or clay fraction analysis by selecting sample portions that are visually free of grease.

2.4 Drilling Procedures

The following basic procedures are used by Midwest to drill a rotasonic hole:

1. core barrels are resonated/rotated 10 feet (3 m) or more into the formation being tested;
2. casing is resonated/rotated to the bit face using water flushing to clear cuttings and sand from the annulus between the casing and the core barrel;
3. the core barrels and any extension rods are withdrawn from the cased hole;
4. core is resonated from the barrel into a plastic sleeve (Plate 6);
5. procedures 1 to 4 are repeated until the desired depth is reached.

In practice, many refinements are made to the above procedures. On exploration programs, the main objective of these refinements is to increase productivity but all too often this is done at the expense of sample quality. On the BRIM program, sample quality was of utmost importance and excellent recovery rates were achieved with little, if any, loss of productivity. The special techniques employed are discussed in the following sections.

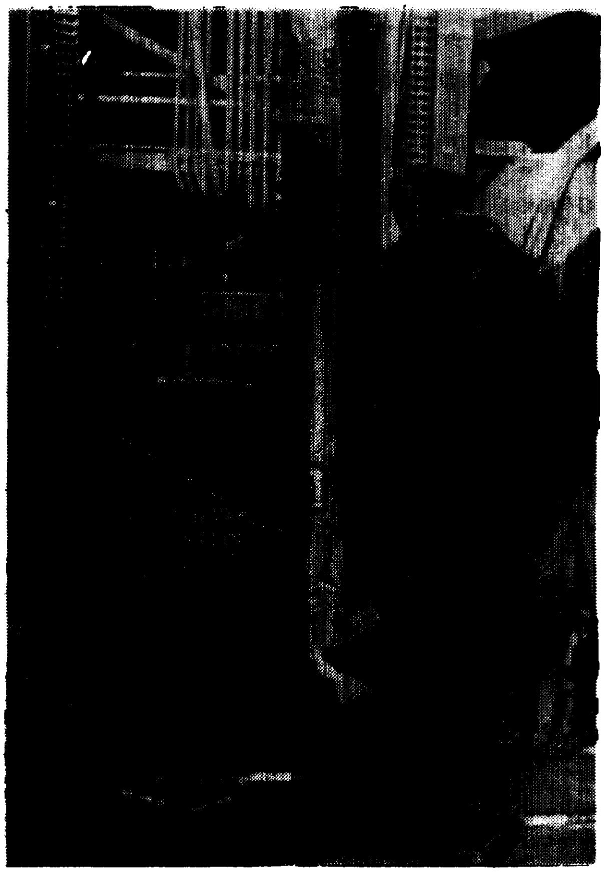

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Plate 6 - Extruding core into plastic sleeve.

Plate 7 - Split till core in boxes.

2.4.1 Core Barrel/Casing Synchronization

Casing must be placed in sonic holes prior to core withdrawal to prevent collapse of stony or water-saturated sections. It is important that the casing be reamed to exactly the same depth as the coring bit. If the casing is stopped short of the bit, caved material may unknowingly be sampled on the next coring run. If the casing is advanced past the bit, the uncored section below the bit will be washed out and lost. If however, the casing is set to its proper depth after each run, a meaningful comparison can be made of the length of core recovered to the distance cored, and any missing or surplus core can be assigned to its proper interval in the hole.

Midwest's core barrels and casing sections are both 10 feet (3 m) long but variations in the lengths of the bits and adapters result in the lead core barrel being nearly one foot longer than the lead casing section. However, the top of the casing must normally be driven one foot closer to the ground than the top of the core barrel because the two pipes are held in the lower and middle chucks respectively, of the three-chuck hydraulic break-out tool. This conveniently makes up the difference in lengths.

On BRIM hole 84-01, it was found that with 7.0 feet (2.1 m) of core barrel and casing in the ground the tops of the two pipes were in their proper positions with respect to the break-out tool. After drilling down the second, third and fourth rod and casing sections, therefore, the bottoms of both pipe strings were successively at 17 (5.2 m), 27 (8.2 m) and 37 feet (11.3 m). White index marks were placed on the tower at one foot (0.3 m) intervals (Plate 2), allowing the depth of the hole to be accurately read from the upper end of the rod at any time. Casing depth was determined by subtracting one foot (0.3 m) from the index mark at the top of the casing.

2.4.2 Core Recovery Log

Sonic drills may produce cores that are equal in length to, longer than or shorter than the interval cored. These variations appear to be due mainly to the manner in which different materials are displaced by the coring bit and to core losses in the hole, but thickening or thinning of the core as it is extruded into the plastic sleeves is also a factor.

The coring bit has a relatively wide kerf of 0.56 inches (1.4 cm) and displaces an annulus of material equal to 33 percent of the inner area of the core barrel. In loose, saturated sands and gravels, the displaced material appears to move outward into the formation, for the core is normally of the same length as the interval drilled.

In cohesive clay and some finer grained till, however, some material appears to move inward into the core barrel. This combined with a stretching of the core during extrusion into the plastic core sleeves produces a core 20 to 30 percent longer than the interval drilled.

Short cores invariably indicate a core loss. On the BRIM program, short cores were variously caused by the following:

1. Blockage of the bit on the first run by roots and dry surface clays;
2. loss of saturated sand and gravel from the bottom of the core barrel during withdrawal from the hole;
3. Restriction of the core barrel opening by a flap valve that was occasionally used in saturated silts and sands;
4. Resistance of hard boulders or pebble beds to coring, resulting in downward movement of the clasts with concomitant displacement of underlying material.

Core recovery data was recorded during the drilling of all holes. Using this information in addition to penetration and stratigraphic data it was possible to identify the cause of variations in core length, thus:

1. Assign surplus or missing core to its proper interval in the hole;
2. take corrective action to reduce or eliminate core losses when entering problem formations.

Most of the core assignment and core recovery problems were identified and resolved in the first five drill holes.

The log of Hole 84-07 (Fig. 3) provides good examples of the methodology employed, and is discussed in detail in the following section.

The overburden section in this hole comprises the following:

Depth Feet	(m)	Unit
0-4	(0-1.2)	Peat
4-54	(1.2-16.5)	Clay
54-66	(16.5-20.1)	Gravel
66-89	(20.1-27.0)	Till
89-112	(27.0-34.1)	Sand
112-116	(34.1-35.4)	Till
116-123	(35.4-37.4)	Bedrock

In the surface peat section of Hole 84-07, the bit became clogged with plant roots and no sample entered the core barrel until the underlying clay was reached.

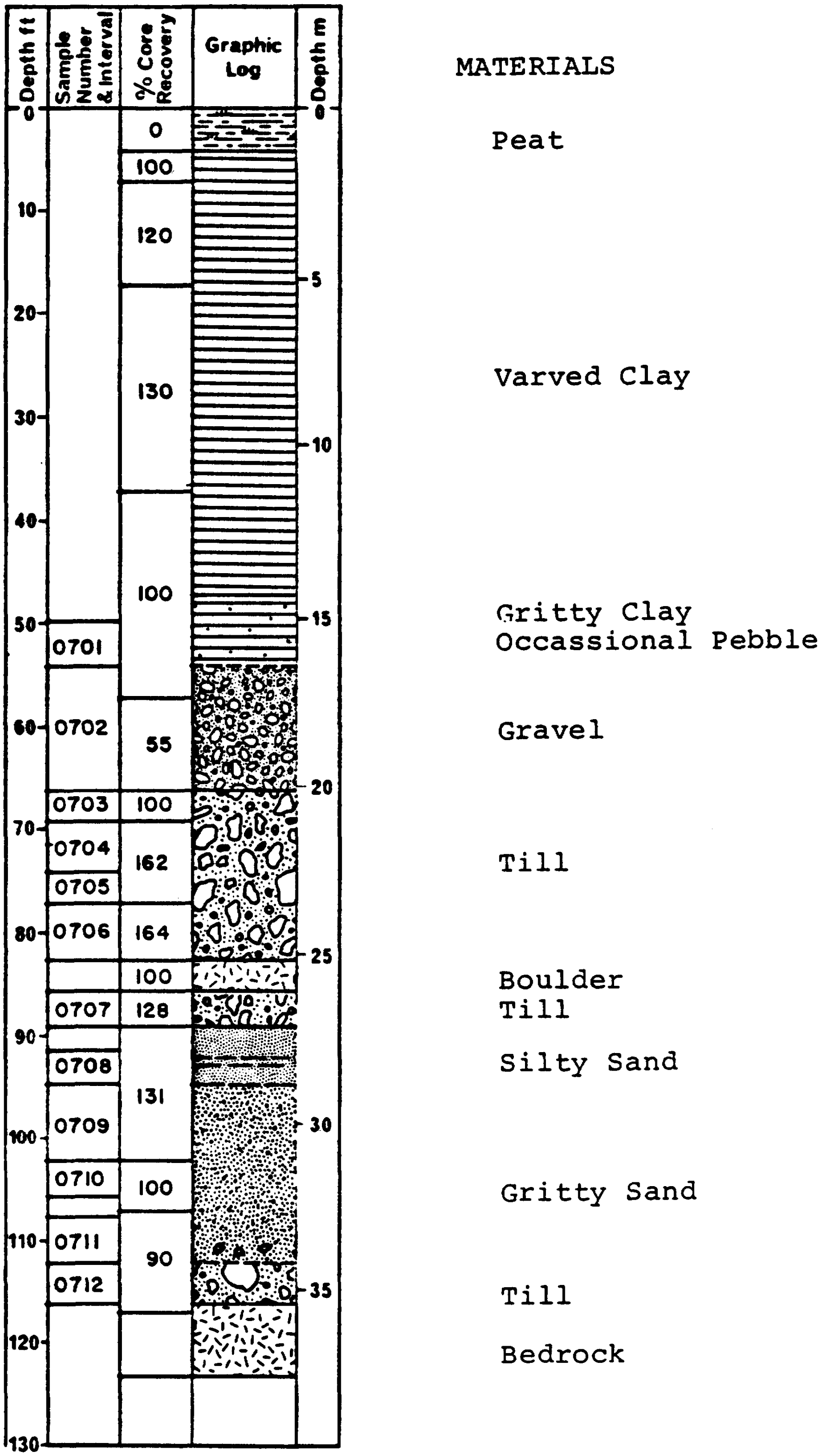

Figure 3 - Hole 84-07 Core Recovery and Log.

Blockages of this type are common when starting a hole, and if long coring runs are made before pulling, it is difficult to ascertain the point at which recovery began. On the BRIM program, at least one 10 foot (3 m) was made at the start of each hole before switching to more efficient 20 to 30 foot (6.1 m to 9.1 m) coring runs through the clay.

The clay was characterized by a low, even resistance to penetration. The runs from 7 to 17 (2.1 to 5.2 m) and 17 to 37 feet (5.2 to 11.3 m) produced surplus core as expected, and the extra core was assumed to be evenly distributed over the section. On the run from 37 to 57 feet (11.3 to 17.9 m), the hole entered gravel below the clay and 20 feet (6.1 m) of clay and gravel core was pulled. A low, uneven resistance typical of a saturated section with pebbly beds was first noted at 54 feet (16.5 m) and the core barrel contained 3.5 feet (1.1 m) of gravel, confirming the position of the contact.

At this point in the hole the drilling procedures were adjusted to optimize recovery of the gravel. On the first five holes, considerable effort had been expended to find a satisfactory sand and gravel coring system as more than half of the core was being lost during pulling. Additional losses were caused by pebbles that washed down to the bit face during reaming of the casing. On the next run, these pebbles were resonated downward, displacing three to five feet (1 to 1.5 m) of underlying section.

Attempts to use a flap valve to improve core recovery failed because the constricted opening of the valve disurbed the core and allowed less than half of it to enter the barrel. Experiments with a drain hole to release water from the extension rods and thereby relieve the pressure on the top of the core were also unsuccessful. With no water standing in the rods, it was impossible to gauge whether the core was holding firm in the barrel, and long pulls often produced empty barrels.

A solution was found in making long coring runs, preferably until the resistance became tight and uneven indicating that compact, stony till had been penetrated. With 30 foot (9.1 m) runs, even if the hole was still in gravel, the core generally packed well in the barrel with only 3 to 5 feet (1 to 1.5 m) or 10 to 15 percent missing due to the pebble problem at the start of the run. If the water level in the extension rods began to fall, indicating that the core was not holding, the coring run was continued until the bit became plugged.

In Hole 84-07, a twelve foot (3.7 m) run was made through the gravel, stopping three feet (0.9 m) into the upper till at 69 feet (21 m). Four feet (1.2 m) of core were missing from the nine foot (2.7 m) gravel section, with the loss probably occurring at the top of the run.

In till, short runs of 6 to 8 feet (1.8 m to 2.4 m) are taken because the extreme resistance of the compact till prevents further advance. Following with casing would reduce the resistance but is impractical due to problems in matching pipe of variable lengths to the various holding chucks in the breakout tool. Also, short pipe sections tend to reduce the strength of the casing string and can lead to costly in-hole losses.

The till cores in Hole 84-07 were 100 to 150 percent longer than the coring runs. Long core is normally recovered in tills unless a hard boulder is driven downward in the hole. On encountering such a boulder, it is desirable to pull any sample in the barrel and core the boulder separately using water flushing to speed penetration and reduce bit weight. This method was used successfully to core a 3 foot (0.9 m) boulder at 82.5-85.5 feet (25.2 to 26.1 m) in Hole 84-07 without driving the boulder into the underlying till.

At a depth of 89 feet (27.0 m) in Hole 84-07, low, even resistance was noted as the hole entered intertill sand. Normally a long run would have been made through the sand to ensure good core recovery. At 102 feet (31.1 m) however, the pressurized sand began to move up into the casing which had been left above the large till boulder. A problem was experienced with the casing shoe and the casing could not be reamed through the boulder until the shoe was changed. Changing the shoe required pulling the core to prevent sanding in. Fortunately a full core section was recovered. After reaming the casing to 102 feet (31.1 m), the rods were lowered to that depth using water flushing to remove five feet (1.5 m) of pebbles that had accumulated in the bottom of the casing. Coring was then continued with full recovery through the sand and through a 4 foot (1.2 m) lower till section to bedrock at 116 feet (35.4 m). The bedrock was soft, fractured Mg rich tholeiitic basalt and was easily penetrated without water flushing. Full recovery of a rubbly core was achieved. With water flushing, as is normally required, in bedrock some core shortening generally occurs due to the loss of fines from crushed sections.

By applying the drilling procedures learned on Holes 84-01 to 84-05 to the remaining holes, consistent core recovery rates of 90-95 percent were achieved.

2.5 **Drill Performance**

The drilling program was budgeted on the following basis:

1. Average overburden thickness of 100 feet (30 m);
2. Average bedrock coring of 5 feet (1.5 m) per hole;

3. One eleven-hour working shift per day;
4. Fifteen percent non-operating down-time;
5. Average 2.5 hours moving time between holes;
6. Average productivity of 1.3 holes in an eleven-hour shift free of down-time, or 12.4 feet per hour.

Actual operating conditions were very close to projections. Overburden thickness averaged 116.1 feet (35.4 m) (Table 1), and only holes No. 84-15 and 84-31 were abandoned before reaching bedrock. A twelve-hour rather than an eleven-hour shift was used and forty-two holes were drilled in a 37 day period from October 10 to November 16. Moving time, defined as the interval after pulling the rods and casing from one hole until the commencement of coring on the next hole, averaged only 1.8 hours despite an average transport distance of 8 km 5 miles). Excellent preparation and organization by Midwest resulted in an enviable 4.6 percent down-time record. The operating period, exclusive of down-time but including moves and the placement of plastic piping in Holes 84-11, 84-28 and 84-39 to allow future borehole logging, was 418 hours. During this period, 5132.5 feet (1564.4 m) of overburden and bedrock were cored for an average production rate of 12.3 feet (3.8 m) per hour.

HOLE NO.	TOWNSHIP	FEET DRILLED OVERBURDEN	BEDROCK	TOTAL
1	Carr	105	4	109
2	Carr	39	5	44
3	Beatty	118	6	124
4	Beatty	107	5	112
5	Carr	98	12.5	110.5
6	Beatty	107	6	113
7	Carr	116	7	123
8	Beatty	71	9	80
9	Hislop	151.5	6.5	158
10	Beatty	156	6	162
11	Hislop	49	6	55
12	Beatty	80	7	87
13	Hislop	112	5	117
14	Hislop	116	8	124
15	Playfair	217	-	217
16	Playfair	104	5	109
17	Hislop	122	5	127
18	Bowman	90	5	95
19	McCann	28	6	34
20	Bowman	116	5	121
21	Carr	252	15	267
22	Taylor	92	5	97
23	Carr	83.5	8.5	92
24	Bowman	92	5	97
25	Currie	116	10	126
26	Currie	114	7	121
27	Taylor	162	4	166
28	Currie	198.5	10.5	209
29	Currie	82	5	87
30	Stock	59	5	64
31	Bond	215	-	215
32	Stock	117	7	124
33	Stock	96.5	5.5	102
34	Taylor	93	6	99
35	Stock	170	5	175
36	Stock	120	6	126
37	Stock	164	8	172
38	Taylor	116	4	120
39	Taylor	144	6	150
40	Taylor	67	5	72
41	Carr	174	4	178
42	Taylor	47	5	52
Totals:				
42		4876	256.5	5132.5

Table 1 - Drill Hole Statistics

Drilling costs including the cost of the low-bed truck, but excluding core boxes and a core logging trailer, totalled $157,712.00 or $30.73 per foot ($100.81 per metre). Lower costs would normally be experienced on an exploration program due to a much closer hole spacing and possibly also to less strict core recovery requirements. However, a suitable productivity rate can be maintained without sacrificing core quality if penetration is closely monitored and long coring runs are made through clay and sand sections as outlined in this report. Particularly discouraged is the practice, reported by some visitors to the drill, of washing casing through the clay until till resistance is felt before starting coring operations. In many BRIM holes, the upper part of the till was loose and resistance was not felt until as much as 5 to 10 feet (1.5 to 3 m) of penetration had been made. In other holes, only 1 to 3 feet (0.3 to 0.5 m) of till was present and the casing would almost certainly have been washed through it to the bedrock surface, leaving no sample to be cored.

2.6 Logging and Sampling Procedures

As Midwest extruded the core into plastic sleeves pertinent footages were marked on the sleeves. The core was then logged and sampled. The procedures used by the OGS will be fully discussed in a separate report and are only briefly outlined herein.

Core logging was done at the drill. On-site logging is highly recommended as any uncertainties in core assignment can be resolved through discussion with the drill crew. Also stratigraphic situations that demand adjustments to drilling procedures can be immediately recognized.

Depending on weather conditions, the plastic encased cores were laid out for inspection on a plywood sheet on the ground or on the floor of the logging trailer. Simulated daylight lighting was provided in the trailer by a portable generator connected to fluorescent fixtures having Cool White bulbs.

Clay cores, with the exception of short sections at till contacts, were discarded after being logged. Till, sand, gravel and bedrock cores, complete with their plastic sleeves, were placed in wooden core boxes (Plate 7). The boxes are five feet (1.5 m) long and are constructed of finished 1 x 6 inch (2.5 x 15.2 cm) spruce lumber, giving inside dimensions of 4.75 x 5.5 inches (12.1 x 14.0 cm). The large diameter is needed to accommodate loose sand and gravel cores that expand in the sleeves as they are extruded from the 4 inch (10.2 cm) core barrels.

The plastic casing was opened with a razor knife and the core was prepared for logging by splitting it lengthwise with a hunting knife. Following logging, all till, sand and gravel sections were sampled over intervals ranging from 5 to 10 feet (1.5 to 3.1 m).

One sample split weighing 7 to 10 kg, representing in till about half of the core, was collected for heavy mineral processing. Coarse clasts were hand picked from the matrix and returned to the core box. The samples were placed in heavy plastic bags, packed in metal 5 gallon (22.7 l) pails and shipped by bus to ODM's heavy mineral laboratory at Nepean, Ontario.

A smaller split weighing approximately 250 grams was collected by the OGS for direct geochemical analysis, particle size analysis and carbonate content determination. In some till and gravel sections, the OGS also collected a representative suite of pebbles from the core.

Plywood lids were placed over the cores remaining in the boxes to prevent spillage. The lids were fastened with screws to facilitate future removal for core inspection. The boxed cores were then transported by pickup truck to a temporary storage facility. Future permanent storage will be at the Ministry of Northern Development and Mines core libraries in Kirkland Lake and Timmins.

3. QUATERNARY STRATIGRAPHY

A detailed description of the Quaternary stratigraphy of the 1984 drill area will be published by OGS. Only a brief outline is presented here.

The majority of holes were collared in glacial clays, deposited in glacial lakes Barlow and Ojibway, and intersected one underlying till unit that rests unconformably on Archean bedrock. Several holes were collared in glaciofluvial esker/delta sediments rather than clay and others intersected subaqueous fan extensions of the deltas between the clay and till. Several holes intersected an old sediment/till section beneath the first till. The old till may also be present but unrecognized in some sections where the intertill sediments are absent.

The glacial lake clays are up to 75.6 m (248 feet) thick and are characterized by gray and tan clay/silt varves that commonly thicken systematically from a few millimetres near surface (distal varves) to several centimetres near the base of the section (proximal varves). Grit is common in the proximal varves, and sand interbeds often appear at the base of the section.

The upper till unit is present in most holes, reaching a maximum thickness of 30 m (100 feet). It was informally named the Matheson till by Hughes (1965). In the Moose River Basin, 240 km to the north, a till unit in the same stratigraphic position was named the Adam Till by Skinner (1973). The average direction of ice advance for the till in the Matheson area is 165 degrees (Baker _et al_ 1980).

The Matheson till is characteristically either very sandy or very clayey, having as its major matrix constituents both recycled pre-Matheson sands and clays, and rock flour produced by the depositing advance. Regionally, half of the till clasts over the Abitibi belt are of Abitibi rocks and the other half are derived from the granitic and carbonate terrain to the north.

The pre-Matheson sediments beneath the till vary from dry, highly compacted varved clays to water-saturated, pressurized sands and gravels. The clays are called "super clays" in the drilling industry due to their resistance to penetration.

Similar sediments have been logged in about 20 percent of several thousand holes drilled between Timmins, Ontario and Matagami, Quebec. They generally occur in buried east-west trending, bedrock valleys where they were protected from erosion during the Matheson glaciation. In the Moose River Basin, where the Quaternary record is much better preserved due to streamlined ice flow over the flat lying Paleozoic rocks, sediments at the same stratigraphic level were named Missinaibi Formation by Skinner (1973). Skinner considered these sediments to be interglacial (post-Illinoisan, pre-Wisconsinan). The possibility that they may relate to a mid-Wisconsinan interstadial phase can not yet be ruled out (Andrews _et al_ 1983).

If the organic sediments below the Matheson till are equivalent to the Sangamonian age Missinaibi Formation then the till beneath them is presumably Illinoian in age. The lower till's matrix, appears to consist mainly of Abitibi belt rock flour rather than recycled sand or clay. Its clasts are mostly of Abitibi belt volcanics. In some holes, the matrix is solidly cemented with calcite.

In the bottom of the Beatty Township pit of Maude Lake Gold Mines Limited, striae and canoe-sized grooves related to the old till strike 240 degrees, suggesting an ice centre in Nouveau Quebec. However, the till contains carbonate clasts, and no carbonate source rocks presently exist in the up-ice direction. Possibly carbonate outliers were present southeast of Hudson Bay prior to the ice advance which deposited the till or this advance may have recycled clasts that had been dispersed southeastward from Hudson Bay in an earlier glaciation.

4. SAMPLE PROCESSING

Heavy mineral concentrates were prepared by Overburden Drilling Management Ltd. (ODM) from the 330 core samples using the procedures shown in the flow sheet of Figure 4. These procedures may be summarized as follows:

The bulk sample is weighed wet and is sieved to 1700 microns (10 mesh). The +1700 micron fraction is weighed wet and the -1700 fraction, which generally represents 80 to 90 percent of the sample, is processed on a shaking table to obtain a preconcentrate. The table concentrate and all fractions obtained from it are weighed dry. The BRIM sample weights will be published in separate reports.

ODM has developed methodology for evaluating free gold anomalies as the samples are being tabled. The use of special feeders and table adjustments causes many gold grains to separate from the other heavy minerals and follow individual paths across the table. These grains are picked from the deck, placed under a binocular microscope, measured to obtain an estimate of their contribution to the eventual assay of the concentrate, and classified as delicate, irregular or abraded (Fig. 5) to determine their approximate distance of glacial transport.

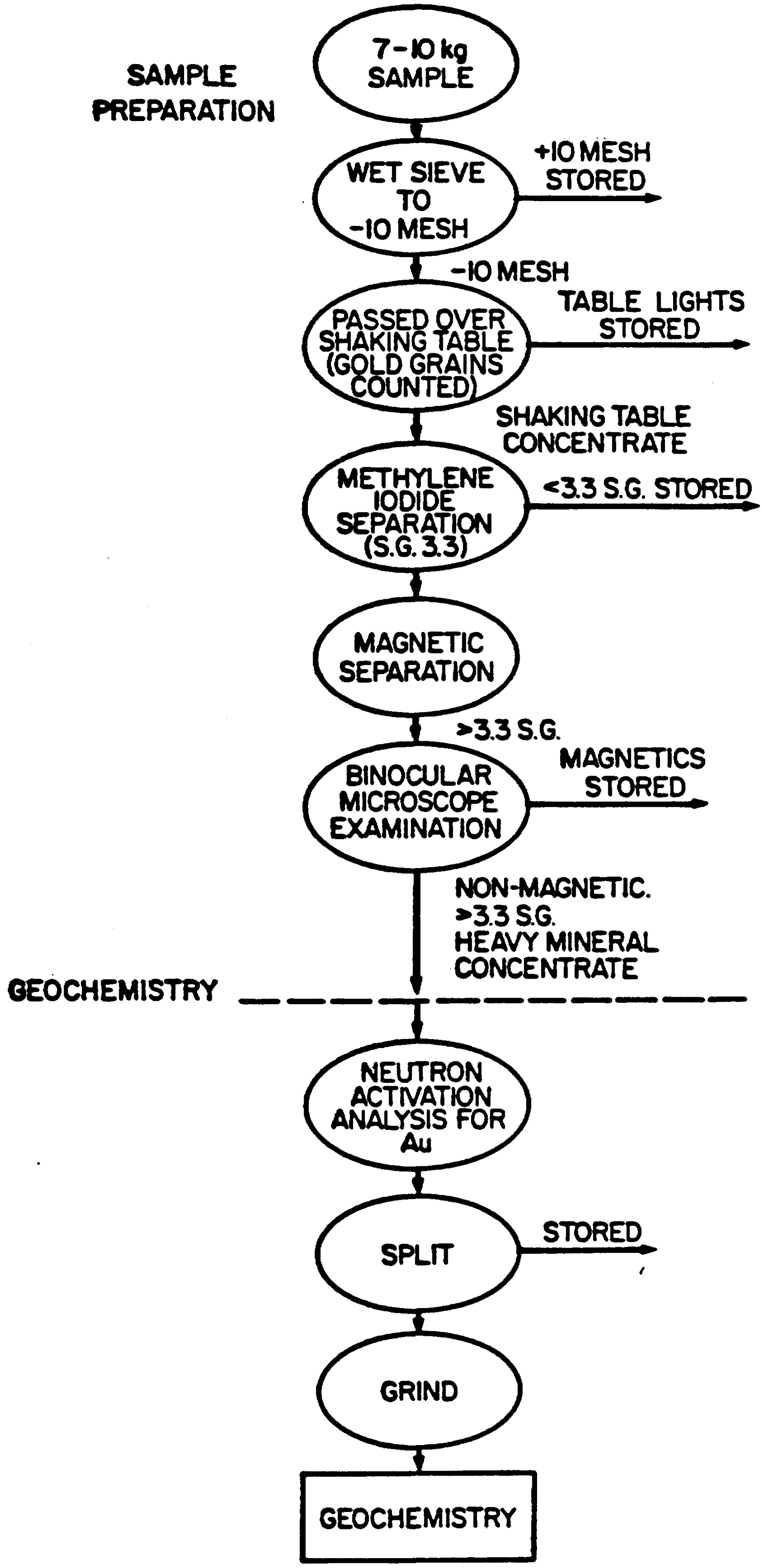

Figure 4 - Sample Processing Flow Sheet

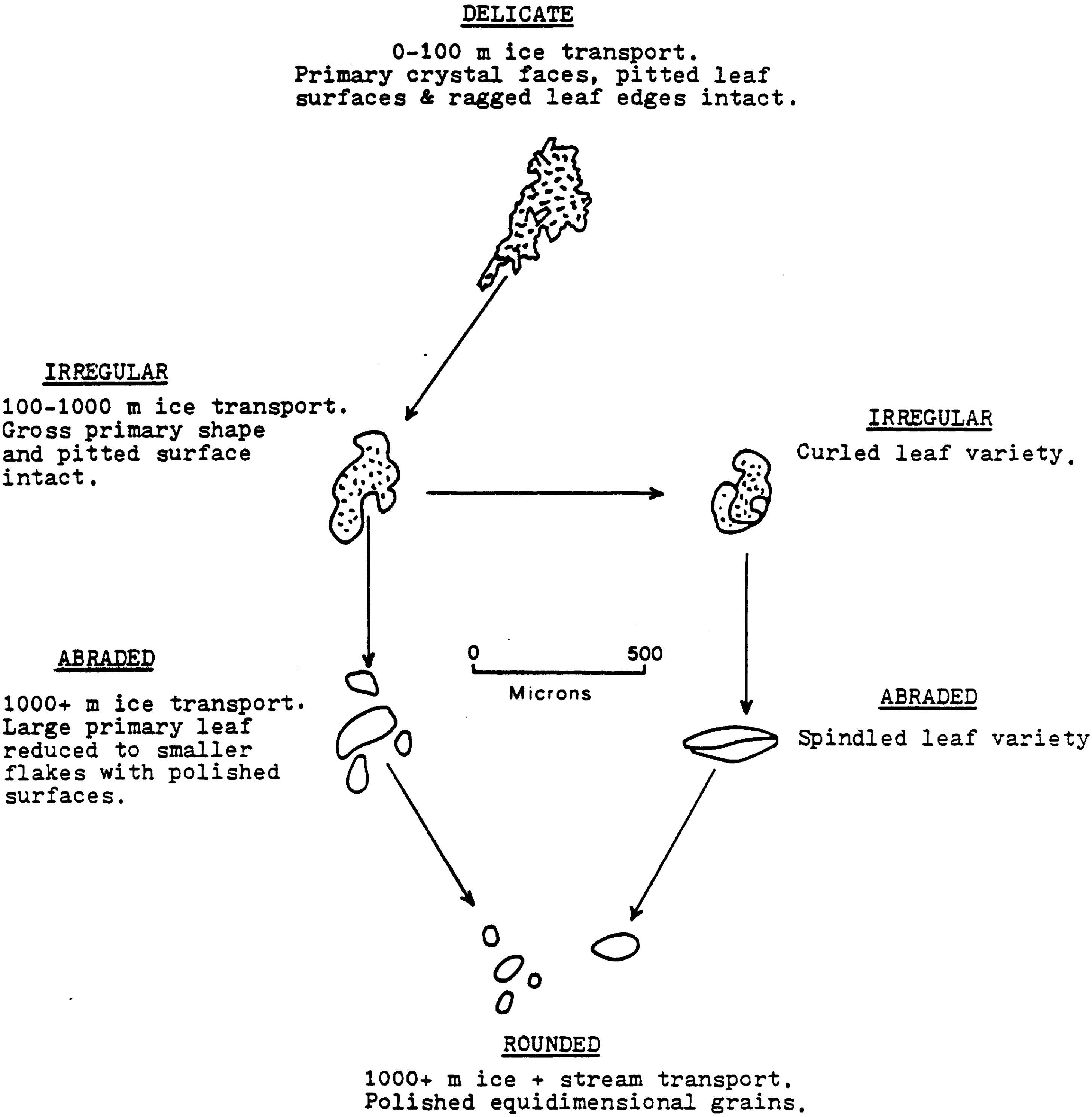

Figure 5 - Effects of glacial transport on gold particle size and shape.
(Developed by Overburden Drilling Management Ltd.)

Magnetite, with a Specific Gravity of 5.2, is the heaviest of the common heavy minerals and normally forms the top mineral "line" on the table above garnet and epidote/pyroxene. Common flake gold coarser than 125 microns separates completely from the magnetite and is readily counted. Fine gold, thick gold and delicate gold travel with the magnetite due to size and shape effects, and only 10 to 20 percent of such grains can be sighted on the table. However, ODM has developed a panning technique to recover the problem particles together with some copper, lead and arsenic pathfinder minerals. All BRIM samples in which one or more gold particles were sighted on the table were panned. The results of the gold grain counts of the 1984 drill samples have been released as an OGS preliminary map (Baker _et al_, 1984).

After tabling, the concentrate is dried and a heavy liquid separation in methylene iodide (Specific Gravity 3.3) is performed. The light fraction (S.G. less than 3.3) is stored and the heavy fraction undergoes a magnetic separation to remove drill steel and magnetite. The BRIM magnetic separates were checked to ensure that they contained not more than two percent pyrrhotite.

The non-magnetic heavy fraction is used for mineralogical and geochemical studies. On gold programs it is desirable to analyze the entire concentrate to minimize the nugget effect that is caused by the particulate nature of most till gold. This can be done by employing the instrumental neutron activation (INA) analytical method in which the sample need not be pulped. The BRIM samples were analyzed by INA, after preparation of mineralogical logs of the concentrates. Further mineralogical checks can be made once radiation has diminished to a safe handling level, normally three weeks after analysis.

5. HEAVY MINERAL LOGS

5.1 Logging Procedures

Binocular heavy mineral point counts were made for each non-magnetic concentrate using the line traverse method. With this method, the sample is mixed in its vial by shaking and several thousand grains are scattered thinly on lined white paper with lines 0.2 mm wide at 6 mm intervals. Eight to twelve cm of line are normally traversed. Each particle on the line is recorded until 100 heavy mineral grains have been counted. Residual quartz and felspar grains, magnetite and drill steel filings are counted but are considered to be foreign materials and therefore are not included in the 100 point total. Thus the number of grains counted for a particular heavy mineral is equal to the percentage of that mineral in the clean portion of the concentrate. If more than 10 quartz/felspar grains are counted, the concentrate is reprocessed in methylene iodide and a second point count is made.

Coarse grains fall on the line more frequently than fine grains. Thus, the grain counts approach volume percent values. However, the line width and line spacing would need to be closely matched to the grain size distribution pattern in a particular sample to obtain a true volume percent figure.

In addition to counting the percentages of the major minerals the concentrates were scanned for accessory minerals that commonly occur in concentrations of less than one percent. These accessory minerals include base metal sulphides and pyrope garnet and chrome diopside, the kimberlite indicator minerals.

5.2 Concentrate Mineralogy

The common heavy minerals in the concentrates are listed in Table 2 and can be assigned to four groups:

1. Major minerals including garnet, epidote, pyroxene, hornblende, hematite and ilmenite. (Heavy carbonate minerals such as siderite which occur in high concentrations in tills in some other areas are notably absent);
2. Sulphide minerals, principally pyrite.
3. Accessory minerals including rutile, zircon, sphene, staurolite, and kyanite;

Mineral	Specific Gravity	Colour	Remarks
GARNET	3.6-4.3	Pink, red-orange	Derived from granitic gneiss north of Abitibi greenstone belt.
EPIDOTE	3.3-3.6	Apple green, yellow-gray-green, off-white, pale green-white, pale green-brown	Derived from altered greenstones and from granitic gneiss.
PYROXENE	3.3-3.6	Gray, gray-green, gray-brown, bottle green, bright green	Mainly diopside/augite from slightly altered, zeolite-facies greenstones. Bright green chrome diopside rare, probably derived from serpentinite rather than kimberlite.
HORNBLENDE	3.0-3.4	Jet black	Occurs as elongate cleavage grains. Derived mainly from granitic gneiss.
ILMENITE	4.7-4.8	Iron black, metallic	Derived from greenstones, intrusives and granitic gneiss.
HEMATITE	5.3	Steel gray, metallic to red, earthy	Derived from greenstones, intrusives and granitic gneisses. Gray and red varieties locally interbedded, indicating iron formation parent.
PYRITE	5.0	Brass yellow. Surface locally oxidized yellow-brown to black	Cubic to massive. Derived mainly from Abitibi greenstones.
RUTILE	4.3	Yellow-brown	Stubby crystals and earthy masses. Derived from local intrusives and distant gneisses.
ZIRCON	4.6-4.7	Colourless to pale yellow-brown	Minute, elongate crystals. Derived from local intrusives and distant gneisses.

Table 2 - Descriptions of Common Non-Magnetic Heavy Minerals

Mineral	Specific Gravity	Colour	Remarks
SPHENE	3.5	Red-brown to yellow-brown	Occurs as crystal wedges. Derived from local intrusives.
STAUROLITE	3.7-3.8	Amber	Occurs as vitreous, equant grains with hackly surface. Derived from granitic gneisses.
QUARTZ and FELDSPAR	2.6-2.7	Colourless, white	Not heavy minerals. Attach to rusty drill steel and hitchhike into concentrates. Typical levels 1-8 percent.

Table 2 (cont'd) - Descriptions of Common Non-Magnetic Heavy Minerals

4. Free gold, which was not noted during binocular logging due to its low concentration but was recorded during table processing and panning in the laboratory;

Pyrope garnet and chrome diopside are notably absent. Considering their relative abundance of these minerals in the Kirkland Lake area to the southeast (Fortescue et al 1984), the kimberlite potential of the 1984 BRIM area appears to be low despite the presence of several major faults in the area.

Most concentrates contain several percent of "unidentified" grains. Rather than being rare minerals, however, most of these grains are either poor specimens of common minerals or were accidentally lost before being classified. For this reason the unidentified minerals were excluded from the 100 point total as were the quartz and drill steel.

Sample 84-08-03 was found to contain 9 percent of a quartz-like mineral after reprocessing to remove quartz. This mineral was identified as diaspore by X-ray methods at Carleton University, Ottawa. Several other problem minerals in the BRIM concentrates were also confirmed by X-ray analysis.

5.2.1 Group 1 - Major Minerals

The major minerals constitute more than 90 percent of most concentrates. Of these, garnet is generally the most abundant, commonly occurring in concentrations of 25 to 45 percent.

Most of the garnet is pale pink in colour but some grains are red-orange. Grains of the latter type were X-rayed in the KLIP program (Averill and Fortescue 1983) and proved to be almandine. No significant garnet sources are present in the Abitibi greenstone belt and all of the garnet is assumed to be derived from granitic gneisses further to the north. The well travelled garnet owes its survival to its lack of cleavage and superior hardness.

Epidote is the second most abundant mineral, generally occurring in concentrations of 15 to 35 percent. This is a reversal of the KLIP program (Averill and Thomson 1981; Routledge <u>et</u> <u>al</u> 1981) where epidote was more abundant than garnet. Epidote sources are present in most of the Abitibi greenstone belt rocks. The abundance in the KLIP samples is due to the KLIP area being located further south in the belt than the BRIM area, thus allowing for increased distance over which incorporation of epidote could take place.

In addition to the common apple green variety of epidote, off-white, pale green-white, pale green-brown and yellow-gray-green varieties are present. Epidote is only marginally heavy (S.G. 3.3-3.6 versus 3.32 for methylene iodide) and, due to the presence of low-density inclusions, as many grains are commonly present in the light fraction as in the heavy mineral concentrates.

Pyroxene is also abundant but occurs in lower concentrations (typically 5 to 20 percent) than epidote. Much of the pyroxene is gray, gray-green or gray-brown in colour and is difficult to differentiate from the dull-coloured varieties of epidote.

The relatively low pyroxene levels in the overburden are noteworthy because many of the zeolite-facies intermediate/mafic volcanic rocks of the Abitibi greenstone belt contain 10 to 50 percent pyroxene. However, this pyroxene has suffered deterioration that has reduced both its hardness and specific gravity. Fresh pyroxene is only marginally heavy (S.G. 3.25-3.55 versus 3.32 for methylene iodide), and most of the soft, altered pyroxene grains that managed to survive glacial transport were rejected in the heavy liquid separation.

Hornblende constitutes 5 to 20 percent of most concentrates. Hornblende is generally considered to be a mid-density mineral but its specific gravity ranges from 3.0 to 3.4, increasing with iron content. The hornblende in the BRIM concentrates is a dense, jet-black variety.

Hematite and ilmenite each constitute 1 to 15 percent of most concentrates. The hematite is generally of the specular variety, although grains of earthy red hematite or banded iron formation occur locally. The ilmenite is a metallic black colour and is distinguished by weak magnetism and lack of octahedral crystal structure from residual magnetite that is present in some concentrates.

5.2.2 Group 2 - Sulphide Minerals

"Pyrite" (pyrrhotite was not differentiated from pyrite) levels generally range from trace to 5 percent and exceed 10 percent in only two samples. A trace of chalcopyrite was seen in Sample 84-28-10. Sphalerite was not seen but is a difficult mineral to identify at low concentrations in samples that are rich in hematite and ilmenite. A few grains of galena and arsenopyrite were recorded in the pan concentrates of some gold-bearing samples.

5.2.3 Group 3 - Accessory Minerals

Most concentrates contain from trace to 1 percent of each of the igneous accessory minerals rutile, zircon and sphene. Metamorphic staurolite and kyanite from the granite gneiss terrane north of the Abitibi greenstone belt are also present, but in lesser concentrations.

Rutile occurs as stubby yellow-brown crystals and earthy masses, zircon as colourless to pale pink or yellow-brown acicular crystals and sphene as red-brown crystal wedges. Staurolite is present as equant, vitreous grains that resemble garnet but have a rubbly surface and are amber-coloured rather than pink. Kyanite occurs as colourless to blue, cleavable prisms that are locally bent.

5.2.4 Group 4 - Gold

Gold was seen on the table in one hundred and thirty-two (40 percent) of the three hundred and thirty samples processed. Panning produced additional grains from some of these samples. Generally one to five grains were recovered but samples from Holes 84-24, 84-28 and 84-34 yielded more than 10 grains (Baker _et al_ 1984).

5.3 Grain Count Reproducibility

To be meaningful, any plot of stratigraphic or geographic variations in heavy mineral percentages must recognize the considerable random variations inherent in a 100 point sample. Parē (1982) used the statistical methods prescribed by Kelley (1971) and Galehouse (1969) to establish the probable percent error at a 95 percent confidence level for minerals occurring at concentrations of less than 5 percent and 5-95 percent, respectively, if 450 grains are counted. Values for a 100 point sample are listed below:

Mineral Percent	1	2	3	4	5	10	20	30	40	50	60	70	80	90
Probable Error (%±)	1	2	3	4	4.4	6	8	9.2	9.8	10	9.8	9.2	8	6

In particular, it should be noted that for minerals occurring in concentrations of less than 5 percent, the probable percent error is equal to the percent of mineral present. That is, if the sample contains 4 percent pyrite and one hundred counts of 100 grains each are made, ninety-five of the counts will yield zero to eight percent pyrite and five will show a greater variance.

Four separate grain counts (Table 3) were made for till sample No. 84-13-17 to determine the reproducibility of the BRIM mineral percentages. The mean variance (standard deviation) for each mineral is considerably less than the probable error margin because mean variance measures the average error rather than the total error range. However the variance is closer to the error margin for hornblende and hematite than for the other minerals, suggesting a biased hornblende and hematite distribution.

Hornblende is the lightest and one of the coarsest minerals present while hematite is the heaviest and one of the finest minerals. It was reasoned that these factors might affect the order in which the minerals were poured from the vial onto the grid paper for counting. The pouring sequence was therefore observed under the binocular microscope with the top half of the vial removed to improve visibility. Even after thorough shaking to homogenize the sample, it was noted that coarse minerals including hornblende tended to congregate preferentially

COUNTING METHOD	MINERAL	PERCENT (4 COUNTS) 1	2	3	4	MEAN	STD.DEV. (%±)	PROBABLE ERROR RANGE (%±)
A	Garnet	28	34	37	28	31.75	3.9	9.2
	Epidote	32	25	25	35	29.25	4.4	9.2
	Pyroxene	10	8	11	11	10.00	1.2	6
	Hornblende	8	15	7	7	9.25	3.4	6
	Ilmenite	6	9	13	12	10.00	2.7	6
	Hematite	14	8	6	4	8.00	3.7	5.4
	Pyrite	1	1	-	2	1.00	0.7	2
	Rutile	-	-	1	1	0.50	0.5	1
	Sphene	1	-	-	-	0.25	0.4	1
B	Garnet	40	27	39	48	38.50	7.5	9.8
	Epidote	30	27	25	20	25.50	3.6	8.7
	Pyroxene	4	13	7	6	7.50	3.4	5.3
	Hornblende	13	9	8	7	9.25	2.3	6
	Ilmenite	8	16	10	6	10.00	3.7	6
	Hematite	5	7	9	9	7.50	1.7	5.3
	Pyrite	-	1	1	4	1.50	1.5	4
	Rutile	-	-	1	-	0.25	0.4	1
C	Garnet	26	27	29	26	27.00	1.2	9.2
	Epidote	30	34	35	35	33.50	2.1	9.5
	Pyroxene	13	10	7	12	10.50	2.3	6
	Hornblende	17	7	10	10	11.00	3.7	6
	Ilmenite	6	7	9	8	7.50	1.1	5.3
	Hematite	6	8	8	7	7.25	0.8	5.3
	Pyrite	1	3	-	-	1.00	1.2	3
	Rutile	1	2	2	2	1.75	0.4	2
	Sphene	-	2	-	-	0.50	0.9	2
D	Garnet	29	30	40	38	34.25	4.8	9.5
	Epidote	30	25	27	25	26.75	2.1	8.7
	Pyroxene	15	13	8	9	11.25	2.9	6
	Hornblende	10	9	10	10	9.75	0.4	6
	Ilmenite	7	10	8	6	7.75	1.5	5.3
	Hematite	5	10	5	10	7.50	2.5	5.3
	Pyrite	3	1	-	2	1.50	0.7	3
	Rutile	1	1	1	-	0.75	0.4	1
	Zircon	-	-	1	-	0.25	0.4	1
	Kyanite	-	1	-	-	0.25	0.4	1

Counting Methods:

A - Scatter on Grid 1, count 100 grains, repeat four times.
B - Scatter on Grids 1 to 4, count 100 grains on each grid.
C - Scatter on Grid 1, count 100 grains on each of four lines.
D - Scatter on Grids 1 and 2, count 100 grains on each of four lines on Grid 2.

Table 3 - Variance in a Hundred Grain Mineral Count

at the perimeter of the cone of minerals during pouring while fine light minerals, also including hornblende, were biased to the top layers of the cone. Fine heavy minerals, including hematite, were biased to the bottom layers. Thus hornblende tends to leave the vial before hematite, resulting in high hornblende/low hematite counts if only a small amount of material is poured from the vial.

The above observations were confirmed by making a continuous pour onto four successive grids and counting the minerals on each grid (Table 3). Hornblende content decreased progressively from 13 percent, levelling off at 7-8 percent, while hematite content increased progressively from 5 percent, levelling off at 9 percent. The mean variances are similar to those of the four initial counts, confirming that pouring inconsistencies are largely responsible for the variance. Further confirmation was provided by making four counts on different lines of the first grid, with these counts showing much less variance. Repeated counts on the second grid did not further reduce the variance but did give slightly lower hornblende and higher hematite percentages that are probably more representative of the true abundances of these minerals.

The above study shows that in a single sample the change in abundance of a particular mineral must be very large to be considered significant. Small but significant changes can best be recognized by treating several consecutive samples from a particular stratigraphic unit as a group.

6. CONCLUSIONS AND RECOMMENDATIONS

The present report is believed to be the first published account of an overburden sampling and Quaternary stratigraphy program in the Abitibi greenstone belt using the rotasonic drilling method. Certainly the program described is the first to use carefully controlled drilling methods. As a result, core recovery was excellent and important new Quaternary stratigraphic information was obtained. It is highly recommended that the rotasonic method be employed on future BRIM programs and in any exploration situation where detailed Quaternary stratigraphy is important.

To ensure satisfactory core recovery and stratigraphc accuracy while maintaining high productivity rates on rotasonic exploration programs, it is specifically recommended that:

1. Penetration be continuously monitored and core recovery be logged;
2. an initial 10-foot coring run be made from surface;
3. twenty to thirty foot coring runs be made through clay, sand and gravel;
4. casing be reamed even with the bottom of the hole after each run;
5. core be logged at the drill site.

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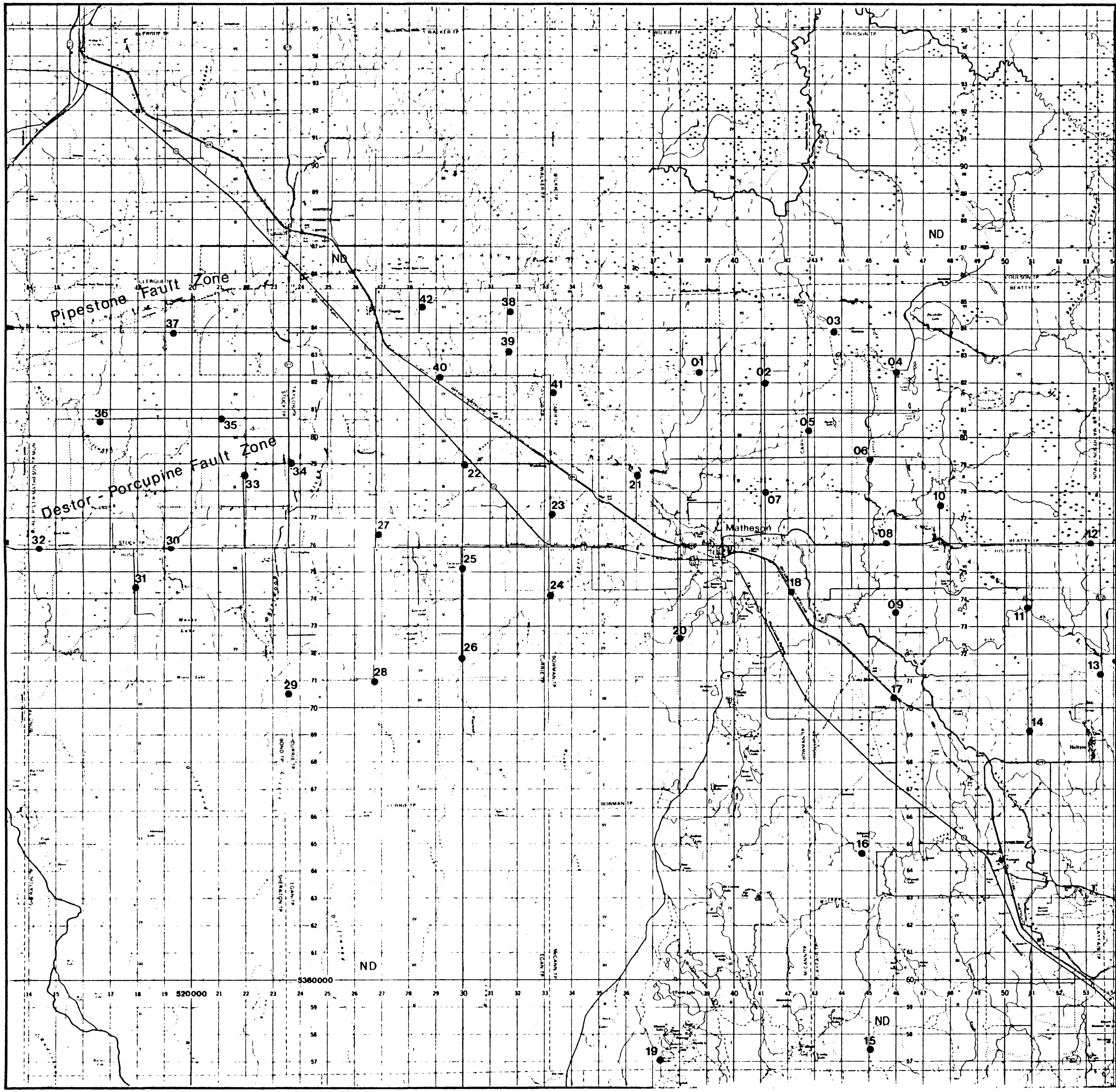


PLAN 1 DRILL HOLE LOCATIONS

Matheson Area

COCHRANE DISTRICT

Scale 1:100 000

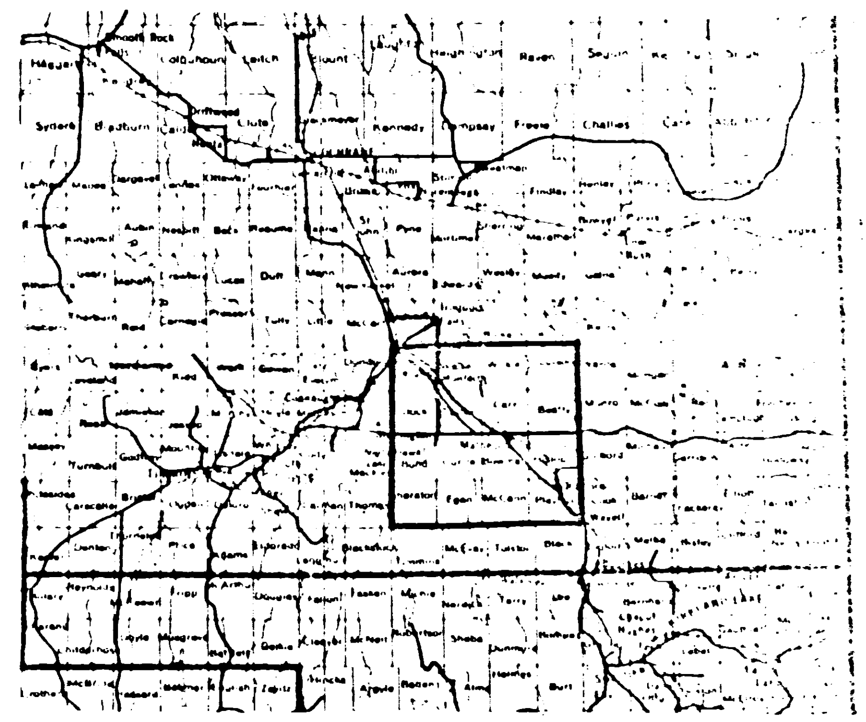
Kilometres 1 0 2 4 6 Kilometres

Miles 1 0 1 2 3 4 Miles

NTS References 42 A/7,8,9,10

ODM GSC Aeromagnetic Maps 294G, 295G, 296G, 297G

ODM Geological Compilation Map 2205



Scale 1 inch to 25 miles

LEGEND

32 Drill hole location with reference number

- Fault Zone