GRANULAR RESOURCES RESEARCH:

SLAVE PROVINCE, N.W.T.

Written By:

Stephen Harrison

August 23, 1994

Land Management Division

Department of Indian Affairs and Northern Development

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1.0 INTRODUCTION

Over the past several years, several large scale mining projects have been proposed for the Slave Geological Province in the Northwest Territories (NWT). In addition to currently operating mines such as Echo Bay's Lupin, Metall Mining Corporation has proposed a base metal mine situated at Izok Lake. As well, BHP Minerals and several other mining firms are in various stages of exploration or development of diamond mines in the Lac de Gras region.

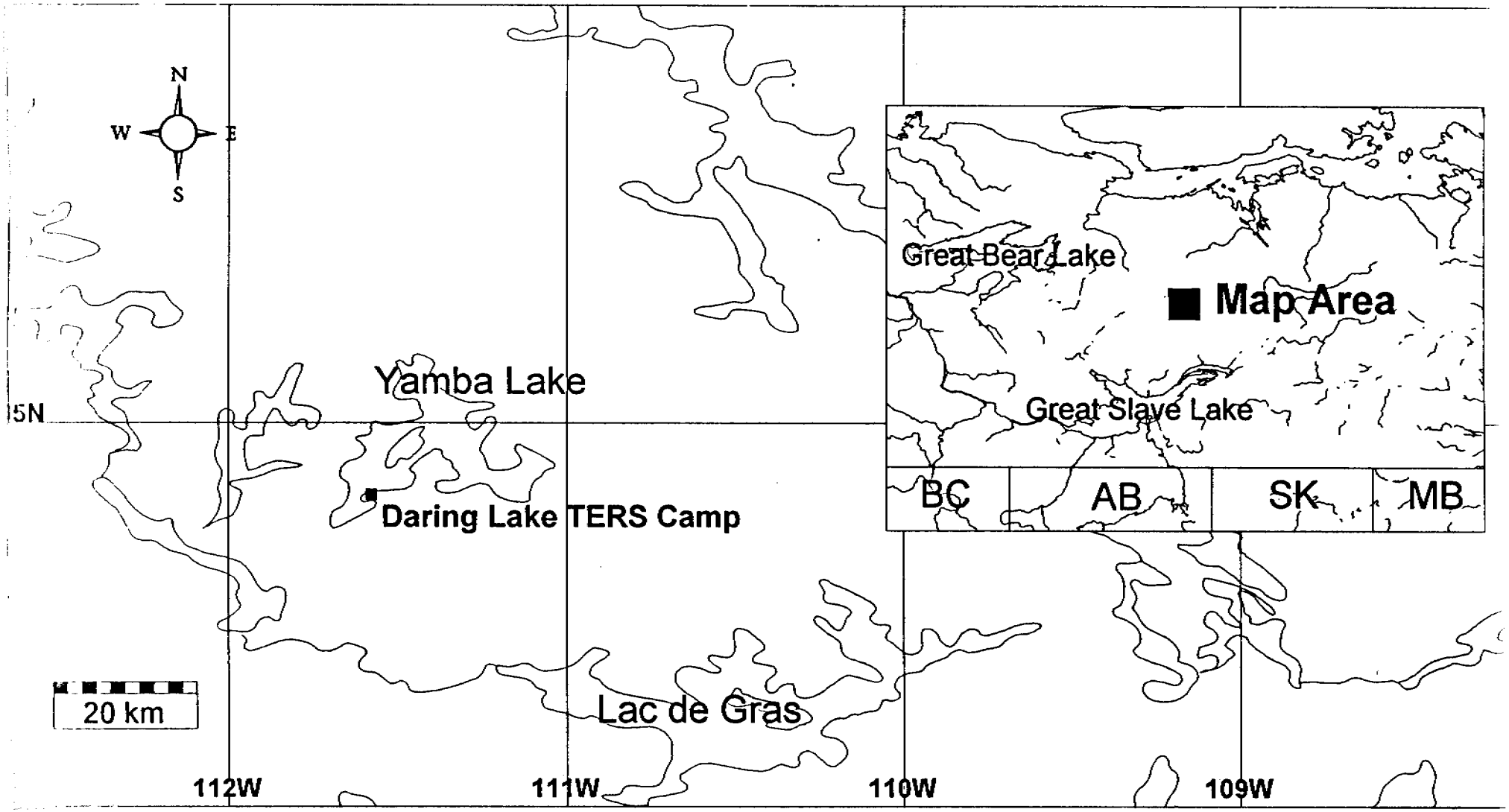
With this increased mining activity in the region, there also comes a greater need for granular materials. Each of these projects will require granular materials for all-weather and winter roads, landing strips, building pads, containment facilities, etc. Other than preliminary airphoto analysis, very little research has been conducted on the availability of granular materials within this remote northern district. With development in the region still in its infancy, the opportunity presents itself to conduct several predevelopment initiatives. These include regional granular material surveys, encouraging the proper use of this valuable and all-too-scarce resource, and cooperating with other levels of the government, and private industry to ensure that all parties concerned act based on facts and understood ideas.

In response to the recent mining activity in the Slave region and the need to understand the relationship between increased development and the impact it will have on the regional ecosystem, the Government of the Northwest Territories (GNWT) Department of Renewable Resources has, with funding from the Department of Indian Affairs and Northern Development (DIAND), established a monitoring station/field camp in the region. The

research station is located on Daring Lake, near the southwest corner of Yamba Lake as shown in map 1.1. One GNWT Renewable Resources study hopes to discover the relationship between mammal denning practices and the granular composition of eskers. During the summer of 1994, the Northern Granular Resources Program of DIAND was invited to take part in the initial phase of this research project covering an area roughly defined by 1:250 000 series NTS mapsheets 76D and 86A.

This report summarizes the geological history of the Slave Geological Province, examines the current exploration and mining activities taking place within the region and DIAND's recent activities with respect to the compilation of information on granular materials in the Slave Province; reports on the field work conducted from the field camp at Daring Lake; and makes several recommendations regarding future DIAND Granular Resources Program activities in the Slave Province.

MAP 1.1 - LAC DE GRAS REGION



2.0 GEOLOGICAL HISTORY

The Slave Geological Province is an area of the Canadian Shield that runs from Great Slave Lake to Coronation Gulf in the Arctic Ocean (see map 2.1). This area of the shield formed 1.8 - 2.8 billion years ago during the Kenoran and Hudsonian orogenies. During these orogenies, or periods of mountain formation, the parent rock was extensively folded, faulted, and thrust up. Most of the Slave Province is underlain by ***granitic***[1] rocks consisting of ***migmatite, mixed gneiss, banded gneiss, and granitic gneiss.***

Approximately 50 - 100 million years ago, long after the formation of the Canadian Shield, ***magmatic*** intrusions into the parent rock occurred. These intrusions are known as kimberlite pipes. Kimberlite is an ***igneous*** rock that typically occurs in cone shaped vertical structures (see figure 2.1). They can also rarely form in the shape of dykes and sills. The texture is inequigranular with large clasts in a fine grained matrix. The clasts are ***ferro-magnesian*** minerals such as ***olivine, phlogopite, and clino- and orthopyroxenes.*** The matrix consists mostly of ***olivine*** with small amounts of ***phlogopite, calcite, serpentine,monticellite, apatite, spinel, and ilmenite.*** Kimberlite may contain diamonds, but only as a very rare component.

The last period of glaciation in the region, the Wisconsin, began approximately 100 000 years ago and lasted for almost 90 000 years. During this time, the landscape was severely

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[1]Definitions for all bold italicized terms can be found in 6.0 GLOSSARY

MAP 2.1 - SLAVE GEOLOGICAL PROVINCE

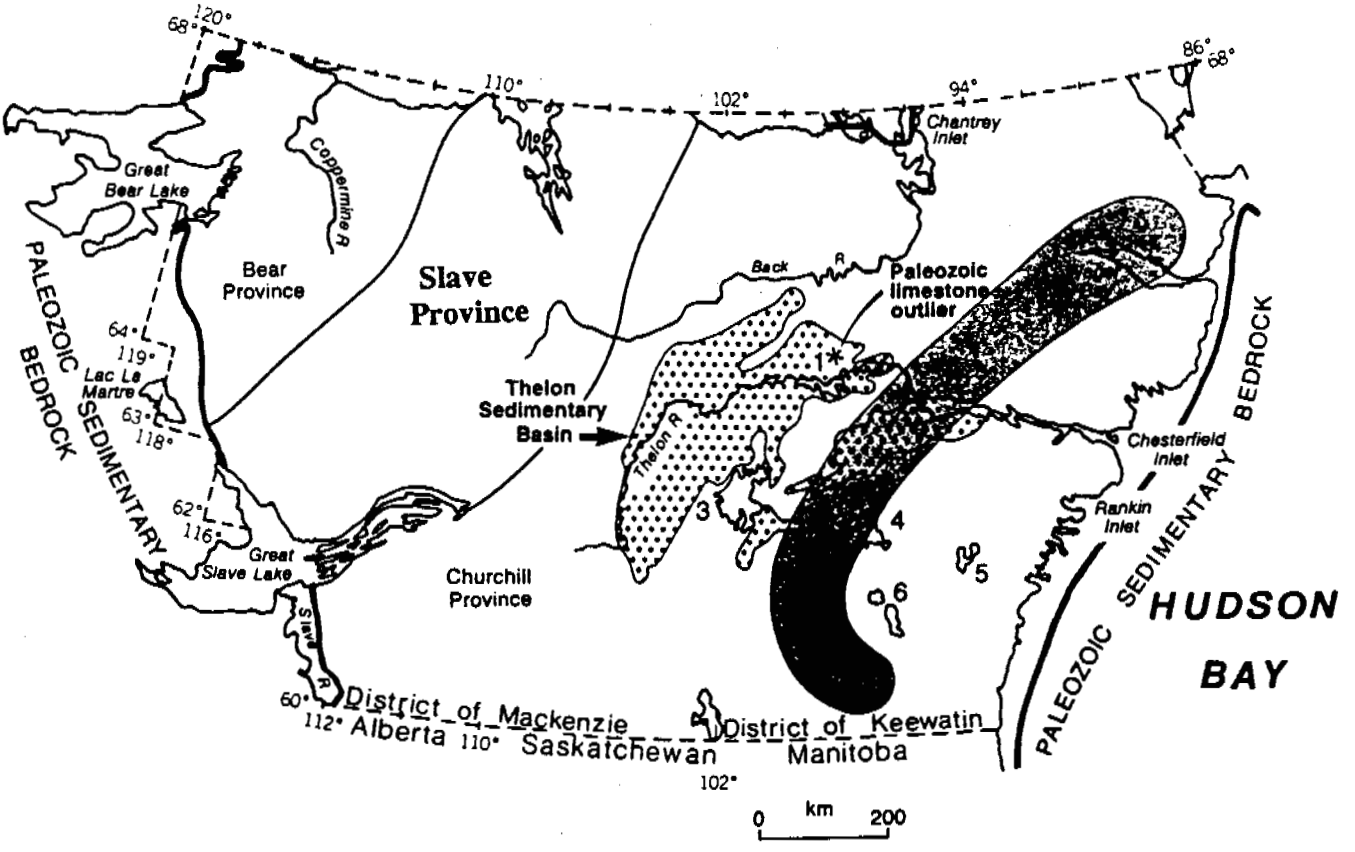
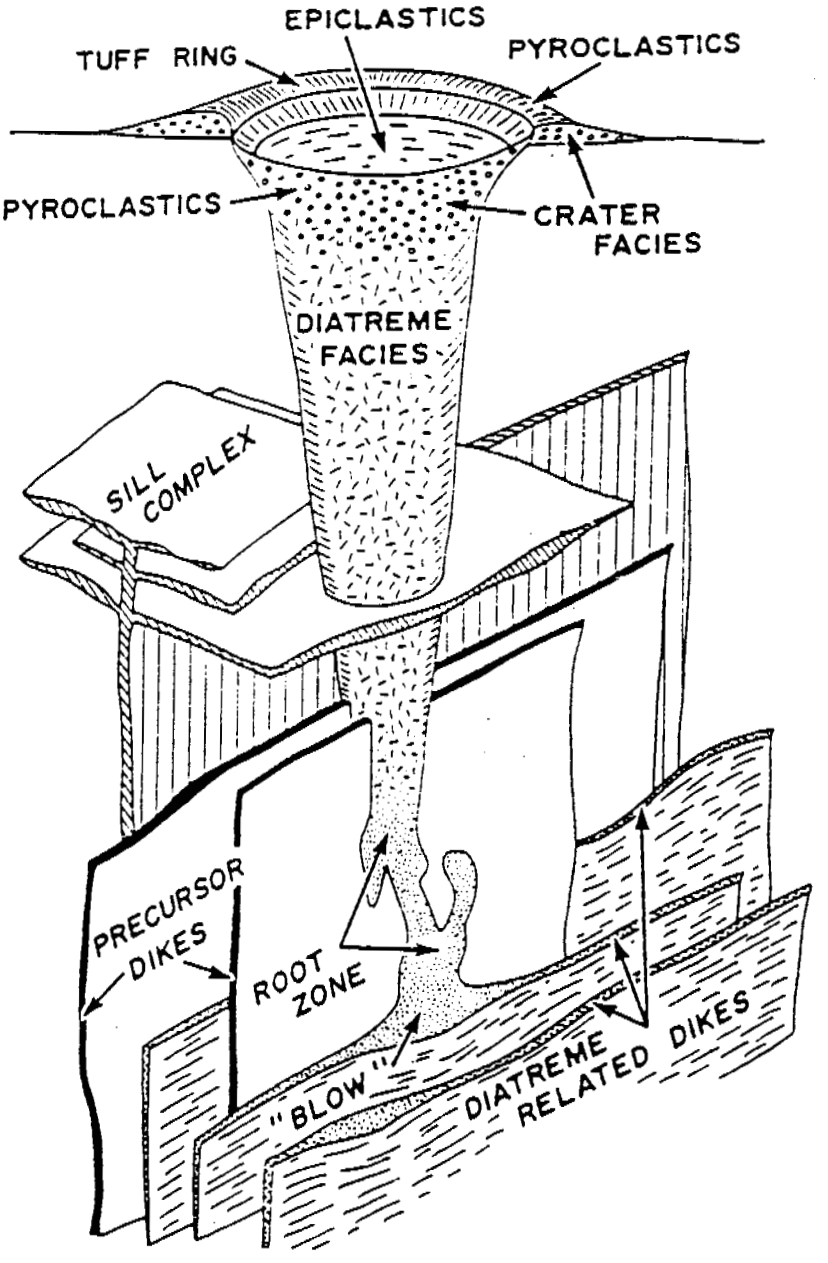


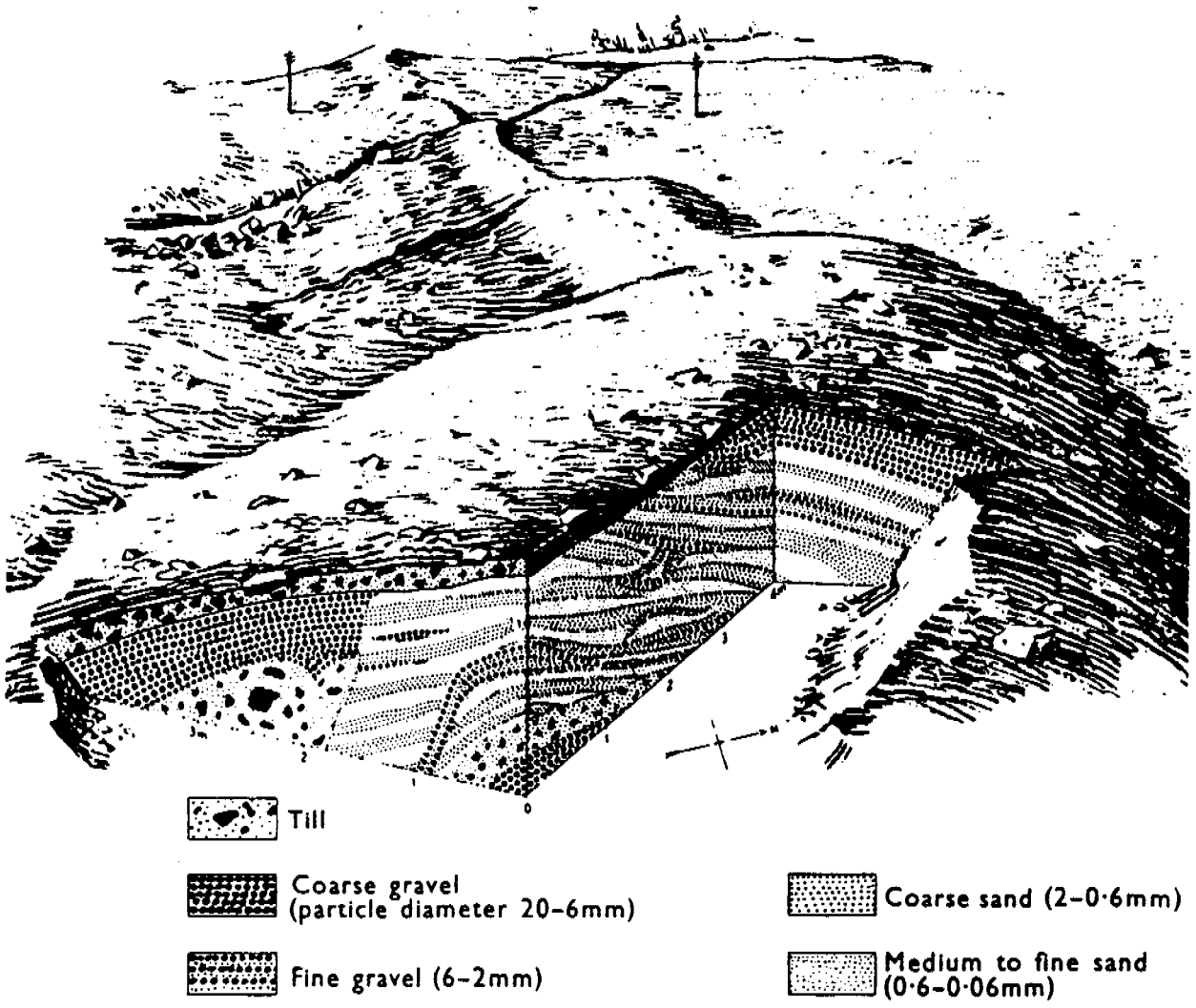
FIGURE 2.1 - MODEL OF A KIMBERLITE PIPE



scoured. When the glaciers finally did begin to retreat, the resulting sediment-laden meltwater streams formed a whole series of landforms such as eskers, ***drumlins***, and ***drift*** deposits. Aylsworth and Shilts (1989) described the study area as consisting of two zones. In the first zone, "a well developed dendritic esker system passes across a till-covered terrain which is commonly drumlinized, but includes only rare occurrences of ribbed moraine." The second zone "comprises extensive areas of nearly drift-free ice-moulded bedrock with virtually no esker development." Field observation during the study suggests that most of the area has a well developed esker system with extensive areas of drift-free bedrock.

Eskers, numerous in the Lac de Gras study region, are long snake-like ridges composed of glacial meltwater sediment. They can run for several kilometres, be 40-50 metres in height, and 500-600 metres in width. Most of the eskers within the study region are narrower and of less height, but do run for several kilometres in length. Eskers occur generally aligned parallel to the direction of ice flow. In the study region, they trend southeast-northwest. Branching is quite common. The grain size is highly variable and can range from sandy silt to coarse gravel to boulders within the same deposit. Figure 2.2 shows the typical structure of an esker deposit with its sinusoidal form and highly variable composition.

FIGURE 2.2 - TYPICAL ESKER STRUCTURE



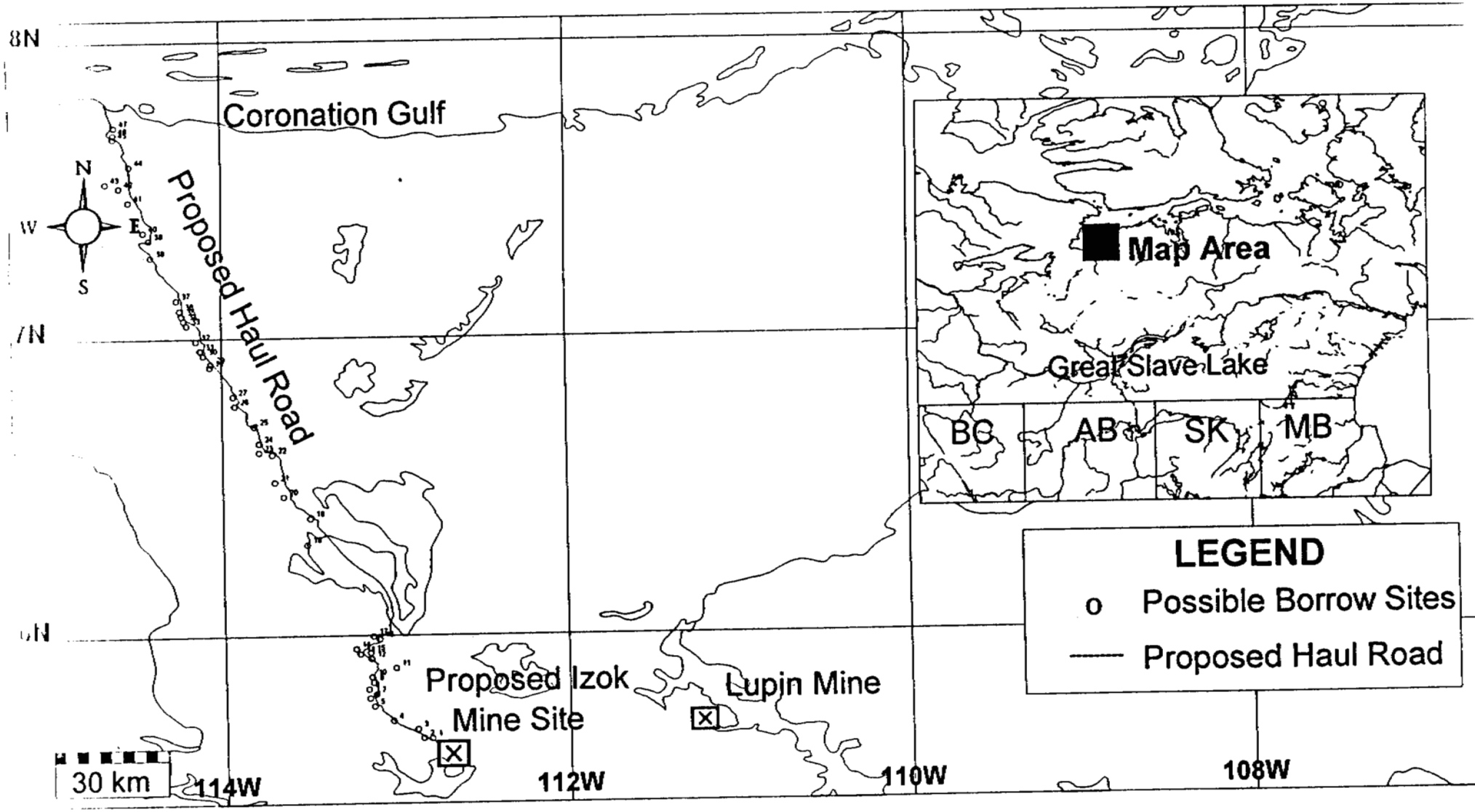
3.0 CURRENT DEVELOPMENT ACTIVITY IN THE SLAVE PROVINCE

Besides the currently operating Lupin gold mine on Contwoyto Lake (see map 3.1), several other projects are in various stages of development. Although currently on hold, Metall Mining Corporation has proposed an open pit base metal mine to be developed in the Izok Lake basin. Map 3.1 shows the location of the mine and winter haul road that has been proposed to haul concentrate north from the mine site to a port facility on Coronation Gulf. Metall officials estimate that approximately 2.8 million cubic metres of granular material will be required for the winter road (EBA, 1993). An all-weather road from Yellowknife to the mine site has also been suggested. This would require even greater amounts of granular material.

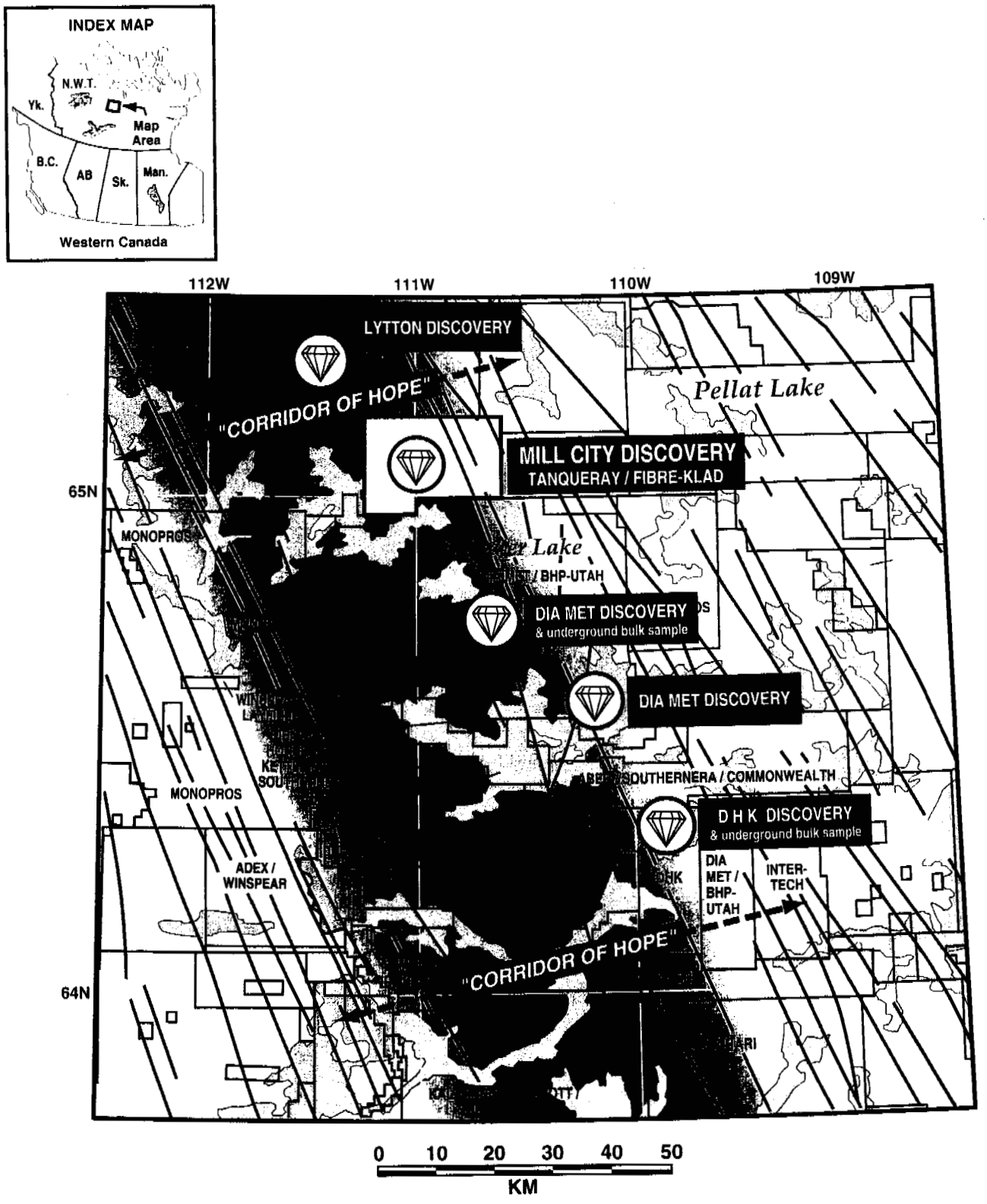
BHP Minerals Canada Ltd. (BHP) is in the process of developing their NWT Diamonds project. BHP hopes to open North America's first diamond mine located just north of Lac de Gras (see map 3.2). The development plan currently consists of mining 3 different ***diamondiferous*** kimberlite pipes. The pipes, named "Koala", "Fox" and "Leslie" are all located under small lakes that BHP has designated by the same name. After draining the lakes, mining will first proceed by open pit and then be followed by underground development.

As shown in map 3.2, several other mining companies are in various stages of exploration or development of diamond mines. These companies include Monopros, Lytton Minerals, Kennicott, DHK and several others. To date, approximately 28 potentially diamond producing pipes have been identified.

MAP 3.1 - PROPOSED IZOK MINE AND HAUL ROAD



MAP 3.2 - STAKED PROPERTY IN THE REGION



Considering the BHP developments alone, the granular material requirements are extensive. Currently under consideration is an all-weather haul road linking BHP's mine site to the Lupin winter road and an airstrip suitable for use by Hercules aircraft and Boeing 737 jets. Granular materials will also be required for use in containment facilities, settling ponds, building pads, etc. Preliminary studies are being conducted on a possible all-weather corridor from Yellowknife to Bathurst Inlet. This road could serve the Lupin mine, the proposed Izok mine, the diamond projects, and would make viable many other potential mining operations. In the future, it is conceivable that the need will arise for increased power generation being supplied by hydroelectric facilities. This will require additional large amounts of granular material.

4.0 RECENT DIAND GRANULAR RESEARCH ACTIVITIES

In order to be prepared for the currently-under-way and future developments taking place within the Slave Province, DIAND's Land Management Division in Hull, Quebec has initiated a series of small research projects focusing on granular resources. These projects include:

1. the preparation of a series of reports by J.D. Mollard and Associates (Mollard) on granular resources in the central arctic,
2. the compilation of granular reports by Mollard and others into a computerized deposit database,
3. preliminary research into the detection of granular deposits using ***remote sensing*** techniques and
4. the participation of DIAND in a GNWT Renewable Resources study hoping to determine the relationship between mammal denning practices and the granular composition of eskers.

4.1 MOLLARD GRANULAR REPORTS

Under contract from DIAND, Mollard has conducted an airphoto-based study of potential granular sources within the Izok Corridor. This corridor represents a series of possible transportation routes between Yellowknife, the proposed Izok mine site, and a shipping

facility on Coronation Gulf. Mollard (1993) identifies almost 900 potential sources of granular materials within 18 1:250 000 series NTS mapsheets. The information within the study consists of deposit location, landform type, and an airphoto-based volume estimate. In 1994, a new contract was issued to Mollard to extend the preliminary airphoto-based mapping of granular deposits east of Bathurst Inlet (an additional 20 1:250 000 NTS mapsheets) including the Lac de Gras region. This report should be available in the Fall of 1994.

4.2 YELLOWKNIFE DEPOSIT DATABASE

As part of the Northern Granular Resources Inventory program, a Yellowknife District deposit database has been initiated. This database is similar to those that have been set up for many districts within the Yukon as well as the Inuvik and Fort Smith Districts within the NWT. These deposit databases contain information on deposit location, status, past use, lab results, etc. Based on two consultants reports (Mollard,1993 and EBA 1993), the Yellowknife District database currently contains almost 900 occurrences. A series of maps showing the locations of each of these deposits have been produced using the desktop mapping system "QUIKMAP" for "Windows". As well, the proposed winter haul road linking Metall's Izok mine to Coronation Gulf has been digitized onto these maps.

4.3 REMOTE SENSING RESEARCH

One problem with conducting studies of granular resources in the North is the vastness of the area. Performing detailed granular investigations is a very costly undertaking. An effective and cost-efficient way of searching would be a very useful tool. To this end, a literature review was conducted into the use of ***remote sensing*** to locate granular resources.

Some research has been conducted in California by the Naval Civil Engineering Laboratory in the United States into the use of vegetation to discriminate parent material for use as aggregate. Minor el al (1988) studied the use of ***Thematic Mapper*** (TM) data to reveal differences in alluvial sites caused by moisture stress on vegetation resulting from aggregate size. Vegetation on well drained, coarse grained material tended to become prematurely desiccated.

In Mollard (1985) the possibility of identification of sand and gravel deposits through the use of high resolution Landsat TM imagery was explored. The report concludes that "the principal advantage of using TM imagery is one of scale. Some 1200 contact airphotos must be obtained in order to cover the same area shown by the four quadrants viewed in TM imagery." Considering the vastness of the North, the use of TM imagery seems ideally suited.

4.4 GNWT RENEWABLE RESOURCES ESKER STUDY

Presently, very little data is available on the relationship between the denning practices of animals and the granular material of eskers within which they den. In the central arctic tundra environment, eskers represent one of the few habitats for many burrowing animals. As well, the eskers represent the primary source of granular material for mining infrastructure projects. Baseline data is needed in order to assess the effect of esker development on the regional ecosystem. In response, GNWT Department of Renewable Resources has established, with financial support from DIAND, a research station in the central arctic. The Tundra Ecosystem Research Station (TERS) is located on Daring Lake, near the Southwest corner of Yamba Lake (see map 1.1). The main purpose of TERS is to "facilitate research, monitoring and mitigation studies associated with mineral exploration and the development of mines and transportation infrastructure in the Lac de Gras area" (GNWT, 1994). The research area is roughly defined by the two 1:250 000 series mapsheets 76D and 86A. Planned research at the camp includes:

1. description and assessment of the plant and animal communities on esker systems within the Lac de Gras region,
2. ground truthing of Landsat imagery of esker systems and tundra habitats in the Slave Province and
3. a quantitative description and comparison of esker den site granular material requirements of bears, wolves, fox and arctic ground squirrels.

The idea of conducting a cooperative research program on eskers was first discussed by DIAND Granular Resources Program and GNWT Renewable Resources personnel in September, 1993 during an aerial and limited ground reconnaissance of potential granular deposits on the proposed Izok winter haul route. Further discussions beginning in April, 1994 identified the opportunity for cooperation in the den site study. GNWT requested the participation of DIAND Granular Resources personnel to provide background data on the characteristics of eskers and to ensure that granular materials sampling and testing conform to standard procedures. The overall objectives of the GNWT den site research program are to:

1. determine the importance of eskers as animal habitats in the region,
2. identify the relationship between esker granular materials and animal denning sites and
3. assess the impact of large scale use of eskers for infrastructure projects on animals.

In preparation for the field study, a reference manual was prepared (Harrison, 1994). This manual contains various studies and research papers describing the formation, characterization, and granular make-up of eskers. This manual contains ten different articles and serves as a detailed reference source on eskers, depositional sedimentary environments, and glacial geology in general.

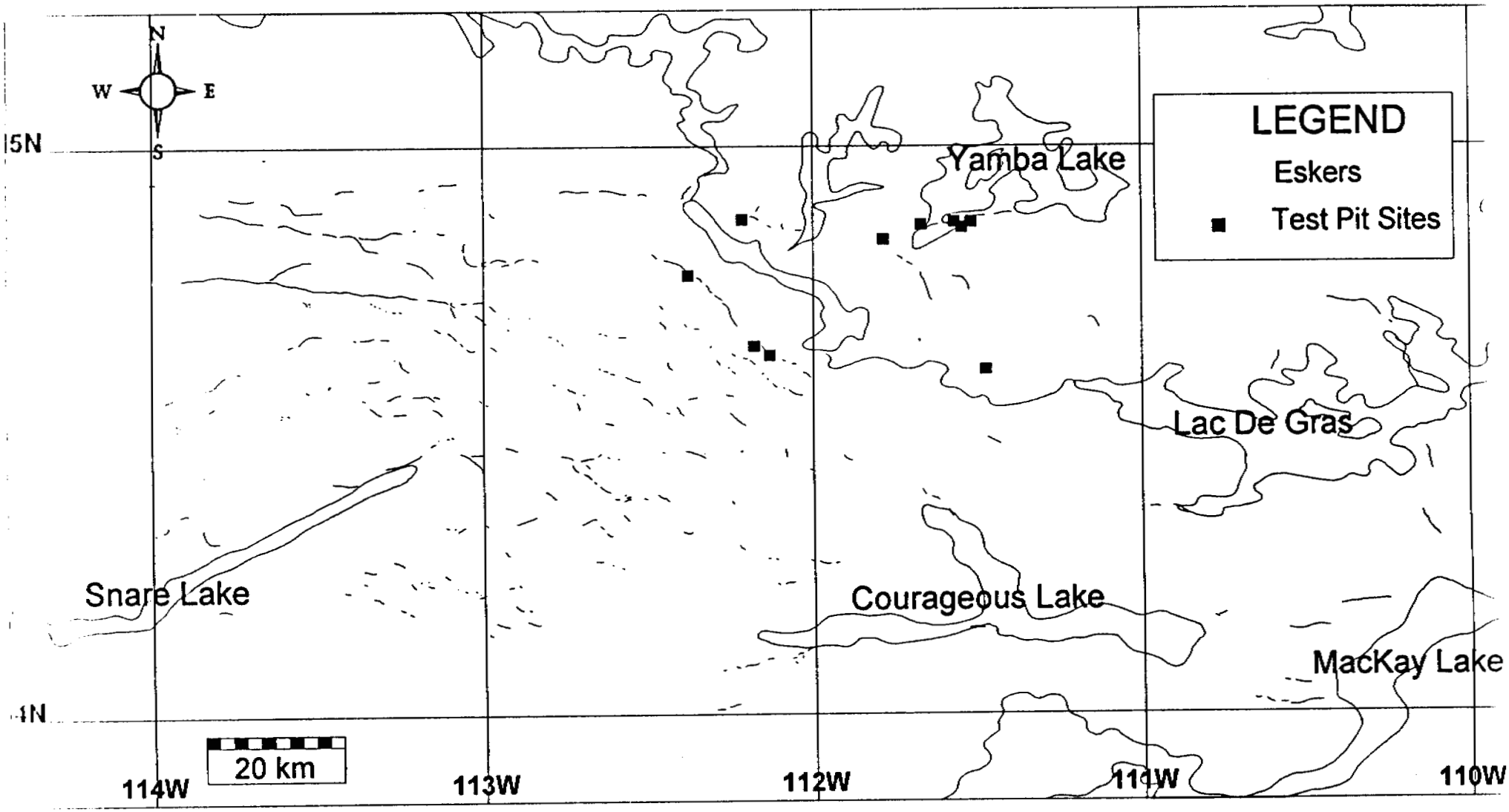
Two articles of particular interest are Aylsworth and Shilts (1989) and John and Sugden (1984). The report by Alysworth and Shilts discusses the glacial geology around the

Keewatin Ice Divide, an area stretching 700 kilometres north from the N.W.T./Manitoba border. The divide is the centre of the Laurentide ice sheet that covered the region in the last ice age. John and Sugden examine the formation and surface appearance of deposits laid down by glacial meltwater.

In order to link the research to the Northern Granular Resources Inventory, all eskers shown on NTS mapsheets 76D and 86A were digitized using the desktop mapping program "QUIKMAP" (see map 4.1). This enables research data to be easily geographically referenced and displayed. As well, possible granular sources based on the upcoming Mollard study will be directly linked to a digitized esker. Hopefully, this report will also identify several new eskers.

Before departure for the field camp, DIAND staff participated in a miniseminar on sampling and testing of eskers conducted by Mr. Terry Jordan of EBA Engineering Consultants Ltd., Yellowknife. This included demonstration and discussion, both in the field and in the laboratory, of sampling and testing techniques for granular materials. During the field portion, most of the accessible deposits in the vicinity of Yellowknife were visited and a sample test pit was dug in one of the loose sand deposits in order to discuss procedures. As well, an esker sampling and testing methods manual (EBA, 1994a), prepared as part of EBA's current contract with DIAND was received and discussed.

MAP 4.1 - ESKERS WITHIN THE STUDY AREA



The general purpose of the sampling program was to compare surface and subsurface conditions (including vegetation, soil particle size and moisture) at den sites, with those near den sites, with conditions at potential quarry sites and with random sites along eskers. After arriving at the field camp, two days were spent with GNWT Renewable Resources staff refining granular sampling techniques, establishing a common methodology and sampling several local denning sites accessible from the camp by foot and boat. Four different species of animals were to be included in the study - grizzly bears, wolves, fox and ground squirrels. Several wolf and bear dens had been previously identified by Renewable Resources during other studies. Others were to be identified during the study using a helicopter. The identification of denning sites from the air was made possible by several key markers:

1. the presence of fireweed. This plant seems to thrive in disturbed areas such as that caused by animal activity.
2. caverns or diggings in the ground.
3. the splaying out of fine granular material indicating a recent dig.

For identification purposes, each sample taken was given a unique name. The name consists of three components - a site identifier, a pit number and a pit type. The site identifier consists of D (den), Q (quarry) and R (random). Possible quarry sites would be identified based on site conditions and topography. Favourable factors include a steep slope, easy accessability and good development potential. This information would serve as baseline

reference data for future studies. Random sites were chosen as a control along the esker at a set interval of ten kilometres. The second component, pit number, represents the sequential number of that pit. The third component, pit type, depends on the site identifier. At each D site, two pits were dug, a D (den) pit and a G/C (geological/control) pit.

The D pit was dug adjacent to the actual den and the G/C pit is a local control pit and was dug in a random location near the D pit. Each Q site has three associated pits, L (left), C (centre) and R (right) based upon the location of the pit relative to the top of the esker and looking along the flightline of the helicopter. Each R site has one pit and alternates between L (left), C (centre), and R (right). For Example, the first site chosen might have samples named D1D and D2G/C. A second site might have a sample named R3L.

Each pit was logged and samples taken according to the following methodology:

1. excavation of test pit - each pit was dug to a depth of approximately 1 metre where possible.
2. acquire granular sample - two samples per pit where acquired, a surface sample and a bulk sample at depth, representing the natural undisturbed soil column.
3. Draw test pit log
4. Video tape site and take picture - a video tape was made of each site for later inspection.
5. Close pit.

Data for each pit was recorded on a Site and Sample Description Sheet as shown in figure 4.1. This sheet includes location information, general site information and relatively detailed information regarding stratigraphy. Description Sheets for all of the pits can be found in Appendix A. Sampling procedures and descriptions followed standard engineering practices. The report "Manual for Sampling Esker Deposits and Laboratory Testing Procedures" (EBA, 1994a) was used as a guideline. Individual samples were double bagged, labelled, and stored in plastic pails for shipment. All samples are being shipped to EBA Engineering Consultants Ltd. in Yellowknife for testing and analysis.

Originally, five days were allocated for sampling and den identification. However, due to mechanical difficulties, the helicopter did not arrive at Daring Lake until the last day of the study. This left only one full day for joint DIAND/GNWT sampling before Stephen Harrison had to leave the camp. To ensure that GNWT personnel could continue the sampling, some additional time was spent before the helicopter arrived carefully reviewing the sampling procedures to help ensure that accurate methods were followed.

Although much less than anticipated, 10 sites were sampled during the one available day. A total of 32 samples were collected. 31 of these samples were den(D) samples and 1 sample was a random(R) sample. Unfortunately, due to the time constraints, no quarry samples were taken for analysis.

FIGURE 4.1 - SITE AND SAMPLE DESCRIPTION SHEET

Site_no _____ Pit_type ____ Date ____/____/____ Time ____:___
Latitude _____ deg. _____ min. _____ sec.
GPS_loc Yes No .
Longitude _____ deg. _____ min. _____ sec.
Site_desc
Topography _____ Slope_dir _____

Sfc_drain _____ Sfc_veget _____

Sfc_matl _____ Cobbles & Boulders: _____% Size _____

Pit_no _____ Pit_depth _____ No_samples _____

Dpth_intvl _____ _____ _____

Princ_comp _____ _____ _____

Usc_symbol _____ _____ _____

Other_comp _____ _____ _____

Mx_gr_size _____ _____ _____

Fines _____ _____ _____

Grading _____ _____ _____

Shape _____ _____ _____

Texture _____ _____ _____

Colour _____ _____ _____

Moisture _____ _____ _____

Site_photo _____ VideoTape No._____

Comments

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Although presentation of the final results and conclusions will have to wait until all samples have been tested and analyzed, some initial observations can be made. Den sites tend to range between sandy silt and coarse sand, with silty sand being most common. Of the 10 den pits sampled, 6 consisted of silty sand. Off den pits averaged a coarse sand with trace gravel to gravelly sand. Grain size curves, moisture contents and further analysis will be presented in a separate report (EBA, 1994b) available in the fall of 1994.

5.0 RECOMMENDATIONS AND CONCLUSIONS

While some progress has been made towards the development of a Yellowknife District deposit database, the information is incomplete at this time. Very little information is known about the deposits used by GNWT Department of Transportation (DOT) personnel along the highway between Yellowknife and Fort Providence. Based upon previous interest expressed in the Northern Granular Resources Inventory program by GNWT DOT in Hay River (see Harrison, 1993), Yellowknife DOT officials should be interested in sharing data.

The identification and evaluation of granular resources in an area as large and undeveloped as the Northwest Territories is a very expensive undertaking. One possible method of examining this large area is through the use of ***remote sensing*** techniques to identify the relationship between grain size, moisture, soil, and vegetation. The possibility of conducting a pilot study in the central arctic similar to Minor el al (1988) (see 4.3) should be examined. This project could be coordinated with the vegetation mapping study being conducted by Renewable Resources and with the GNWT Centre for Remote Sensing. Given the likelihood of development in the area, there will certainly be future opportunity to ground truth the results of the pilot study prior to applying these techniques to larger, relatively unknown areas.

During the summer of 1994, DIAND had the opportunity to participate in the initial phase of the TERS esker research project being conducted by GNWT Renewable Resources. The

mutual interest that DIAND and Renewable Resources have in the proper management of the North's resources resulted in a successful initial study. Renewable Resources was able to accurately sample the granular material within denning sites and DIAND has been able to gather some initial baseline granular resources data. The experiences and collaboration between DIAND and GNWT should be continued by expanding the field study area to produce a regional granular materials inventory within the Lac de Gras area. The field sampling program should be extended to include ground truthing potential granular sources identified by Mollard (1993 and in progress).

If the results of this study would be beneficial to Renewable Resources, the TERS camp might be used as a base camp if available. The location of the TERS camp makes it an ideal location from which to conduct the study. The investigation could be coordinated at the office by the Geotechnical Advisor and conducted in the field by two or three field technicians over a two to four week period. As well, continued assistance could be provided to Renewable Resources for the purposes of sampling.

6.0 GLOSSARY

All definitions have been taken from Stiegeler (1976).

APATITE - A phosphorus mineral common in igneous rocks.

CALCITE - A common rock forming mineral with the chemical formula $CaCO_3$.

CLINO AND ORTHOPYROXENE - A group of ferromagnesian rock forming minerals.

DIAMONDIFEROUS - In the case of kimberlite pipes, any pipe which contains relatively abundant quantities of diamonds.

DRIFT - Glacial and glaciofluvial deposits.

DRUMLIN - A glacial deposit tending to form in groups and aligned parallel to the direction of ice movement. The deposit is roughly egg shaped containing stratified or unstratified material.

FERROMAGNESIAN - A mineral which contains the components iron and magnesium.

GNEISS - A coarse grained metamorphic rock in which quartz and feldspar predominate over mica.

IGNEOUS - Rocks that have crystallized from a magma.

ILMENITE - A black mineral found in igneous and ***metamorphic*** rocks.

METAMORPHIC - A rock in which mineralogical and chemical changes take place as a result of increasing temperature and pressure.

MAGMATIC - Igneous rocks formed from the solidification of magma within a reservoir within the earth's lithosphere.

MIGMATITE - A coarse grained, banded mineral consisting of quartz/feldspar and biotite/hornblende bands.

MONTICELLITE - A calcium bearing variety of olivine.

OLIVINE - A group of rock forming minerals with the general formula R_2SiO_4 where:

R stands for magnesium, iron, manganese or calcium; Si represents silicon and O represents oxygen.

PHLOGOPITE - A mineral that has a layered structure and cleaves as the pages of a book would separate.

REMOTE SENSING - The use of reflected or radiated electromagnetic energy to collect data about an object.

SERPENTINE - One of a group of layered minerals having the general composition $Mg_3Si_2O_5(OH)_4$.

SPINEL - A mineral occurring in high-temperature ***metamorphosed*** rocks.

THEMATIC MAPPER - One of a series of imaging devices used in the Landsat series of satellites.

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APPENDIX A: SAMPLE DESCRIPTION SHEETS

SITE AND SAMPLE DESCRIPTION SHEET

Site_no D 1 Pit_type G Date 07/16/94 Time

Latitude 64.00000 deg. 52.0 min. 13.0000 sec.
Longitude 111.00000 deg. 34.0 min. 49.0000 sec. Gps_loc .

Site_desc north facing slope of esker

Topography undulating Slope_dir north

Sfc_drain dry Sfc_veget present

Sfc_matl cobble/boulders Cobbles & Boulders: 15% Size 0

Pit_no D1G/C Pit_depth 1.00 No_samples 1

Dpth_intvl 0.5-1.0

Princ_comp sand

Usc_symbol sp

Other_comp some gravel

Mx_gr_size 25

Fines none

Grading poor

Shape rounded

Texture

Colour

Moisture dry

Site_photo Video_t_p SH

Comments

Prepared by Stephen Harrison

SITE AND SAMPLE DESCRIPTION SHEET

Site_no D 2 Pit_type G Date 07/16/94 Time

Latitude 64.00000 deg. 51.0 min. 30.0000 sec.
Longitude 111.00000 deg. 37.0 min. 0.0000 sec. Gps_loc .

Site_desc top of esker ridge - surrounding kettle lake; south slope of 40; north slope of 25
Topography undulating Slope_dir north

Sfc_drain dry Sfc_veget present

Sfc_matl cobble/boulder Cobbles & Boulders: 15% Size 0

Pit_no D2G/C Pit_depth 0.70 No_samples 1

Dpth_intvl 0.0-0.7

Princ_comp sand

Usc_symbol sp

Other_comp gravely

Mx_gr_size 30

Fines none

Grading poor

Shape rounded

Texture

Colour

Moisture dry

Site_photo Video_t_p SH

Comments

Prepared by Stephen Harrison

SITE AND SAMPLE DESCRIPTION SHEET

Site_no D 2 Pit_type D Date 07/17/94 Time

Latitude 64.00000 deg. 51.0 min. 30.0000 sec.
Longitude 111.00000 deg. 37.0 min. 1.0000 sec. Gps_loc .

Site_desc top of esker ridge - surrounding kettle lake; south slope of 40;
north slope of 25
Topography undulating Slope_dir north

Sfc_drain dry Sfc_veget present

Sfc_matl cobble/boulder Cobbles & Boulders: 15% Size 0

Pit_no D2D Pit_depth 1.00 No_samples 2

Dpth_intvl 0.3-1.0

Princ_comp fine sand

Usc_symbol sp

Other_comp trace silt,trace gravel

Mx_gr_size 10

Fines present

Grading poor

Shape rounded

Texture

Colour

Moisture damp

Site_photo Video_t_p SH

Comments

Prepared by Stephen Harrison

SITE AND SAMPLE DESCRIPTION SHEET

Site_no D 3 Pit_type G Date 07/19/94 Time 13:30

Latitude 64.00000 deg. 51.0 min. 54.0000 sec.
Longitude 111.00000 deg. 36.0 min. 14.0000 sec. Gps_loc .

Site_desc low flank of esker just above beach

Topography undulating Slope_dir south facing

Sfc_drain dry Sfc_veget present

Sfc_matl organics Cobbles & Boulders: 0% Size 0

Pit_no D3G/C Pit_depth 0.40 No_samples 2

Dpth_intvl 0.1-0.4

Princ_comp sand

Usc_symbol sp

Other_comp some cobble, trace gravel

Mx_gr_size 130

Fines none

Grading gap

Shape well rounded cobble

Texture

Colour lit. brown

Moisture dry

Site_photo FM Video_t_p SH

Comments unable to dig past 0.4 m due to presence of cobble

Prepared by Stephen Harrison

SITE AND SAMPLE DESCRIPTION SHEET

Site_no D 3 Pit_type D Date 07/19/94 Time 14:45

Latitude 64.00000 deg. 51.0 min. 52.0000 sec.
Longitude 111.00000 deg. 36.0 min. 15.0000 sec. Gps_loc .

Site_desc edge of embankment of flank of esker

Topography undulating Slope_dir south

Sfc_drain dry Sfc_veget present

Sfc_matl organics Cobbles & Boulders: 0% Size 0

Pit_no D3D Pit_depth 0.80 No_samples 2

Dpth_intvl 0.15-0.8

Princ_comp silt

Usc_symbol

Other_comp sandy

Mx_gr_size 40

Fines present

Grading poor

Shape

Texture

Colour light gray

Moisture dry

Site_photo FM Video_t_p SH

Comments 1 large cobble at 0.4 m

Prepared by Stephen Harrison

SITE AND SAMPLE DESCRIPTION SHEET

Site_no D 4 Pit_type D Date 07/19/94 Time 16:30

Latitude 64.00000 deg. 51.0 min. 29.0000 sec.
Longitude 111.00000 deg. 38.0 min. 17.0000 sec. Gps_loc .

Site_desc low flank of esker

Topography undulating Slope_dir south

Sfc_drain dry Sfc_veget present

Sfc_matl organics Cobbles & Boulders: 0% Size 0

Pit_no D4D Pit_depth 0.70 No_samples 2

Dpth_intvl 0.1-0.7

Princ_comp sand

Usc_symbol

Other_comp trace gravel, fines

Mx_gr_size

Fines present

Grading poor

Shape well rounded

Texture

Colour lit. brown

Moisture dry

Site_photo FM Video_t_p SH

Comments

Prepared by Stephen Harrison

SITE AND SAMPLE DESCRIPTION SHEET

Site_no D 4 Pit_type G Date 07/19/94 Time

Latitude 64.00000 deg. 51.0 min. 29.0000 sec.
Longitude 111.00000 deg. 38.0 min. 19.0000 sec. Gps_loc .

Site_desc south facing lower flank of esker

Topography undulating Slope_dir south

Sfc_drain dry Sfc_veget present

Sfc_matl organics Cobbles & Boulders: 0% Size 0

Pit_no D4G/C Pit_depth 1.00 No_samples 2

Dpth_intvl 0.0-1.0

Princ_comp silt

Usc_symbol

Other_comp sandy

Mx_gr_size

Fines present

Grading poor

Shape subangular cobble

Texture

Colour lit. brown

Moisture dry

Site_photo FM Video_t_p SH

Comments 1 cobble in pit @ 0.3 m

Prepared by Stephen Harrison

SITE AND SAMPLE DESCRIPTION SHEET

Site_no D 5 Pit_type D Date 07/19/94 Time 21:40

Latitude 64.00000 deg. 52.0 min. 16.0000 sec.
Longitude 111.00000 deg. 33.0 min. 59.0000 sec. Gps_loc .

Site_desc

Topography undulating Slope_dir south

Sfc_drain dry Sfc_veget present

Sfc_matl organics Cobbles & Boulders: 0% Size 0

Pit_no D5D Pit_depth 0.80 No_samples 2

Dpth_intvl 0.0-0.8

Princ_comp med. sand

Usc_symbol sw

Other_comp trace fines

Mx_gr_size 30

Fines present

Grading good

Shape well rounded

Texture

Colour lit. brown

Moisture dry

Site_photo FM Video_t_p SH

Comments

Prepared by Stephen Harrison

SITE AND SAMPLE DESCRIPTION SHEET

Site_no D 5 Pit_type G Date 07/19/94 Time 21:40

Latitude 64.00000 deg. 52.0 min. 16.0000 sec.
Longitude 111.00000 deg. 33.0 min. 59.0000 sec. Gps_loc .

Site_desc low ridge perpendicular to esker

Topography undulating Slope_dir west

Sfc_drain dry Sfc_veget present

Sfc_matl organics Cobbles & Boulders: 0% Size 0

Pit_no D5G/C Pit_depth 1.00 No_samples 2

Dpth_intvl 0.2-1.0

Princ_comp medium sand

Usc_symbol SW

Other_comp trace gravel

Mx_gr_size 20

Fines present

Grading good

Shape well rounded

Texture

Colour red/brown

Moisture dry

Site_photo FM Video_t_p SH

Comments

Prepared by Stephen Harrison

SITE AND SAMPLE DESCRIPTION SHEET

Site_no D 6 Pit_type D Date 07/22/94 Time

Latitude 64.00000 deg. 50.0 min. 9.0000 sec.
Longitude 111.00000 deg. 47.0 min. 15.0000 sec. Gps_loc .

Site_desc

Topography undulating Slope_dir

Sfc_drain dry Sfc_veget present

Sfc_matl sand Cobbles & Boulders: 0% Size 0

Pit_no D6D Pit_depth 0.90 No_samples 2

Dpth_intvl 0.15-0.9

Princ_comp fine sand

Usc_symbol sp

Other_comp some silt

Mx_gr_size

Fines present

Grading poor

Shape

Texture

Colour lit. brown

Moisture dry

Site_photo FM Video_t_p SH

Comments

Prepared by Stephen Harrison

SITE AND SAMPLE DESCRIPTION SHEET

Site_no D 6 Pit_type G Date 07/22/94 Time

Latitude 64.00000 deg. 52.0 min. 57.0000 sec.
Longitude 112.00000 deg. 12.0 min. 57.0000 sec. Gps_loc .

Site_desc low esker ridge

Topography undulating Slope_dir

Sfc_drain dry Sfc_veget present

Sfc_matl gravel Cobbles & Boulders: 5% Size 1000

Pit_no D6G/C Pit_depth 1.00 No_samples 2

Dpth_intvl 0.1-1.0

Princ_comp medium sand

Usc_symbol SW

Other_comp some fines

Mx_gr_size

Fines present

Grading good

Shape

Texture

Colour lit. brown

Moisture dry

Site_photo FM Video_t_p SH

Comments 21 m from D6D

Prepared by Stephen Harrison

SITE AND SAMPLE DESCRIPTION SHEET

Site_no R 7 Pit_type C Date 07/22/94 Time 9:15

Latitude 64.00000 deg. 47.0 min. 30.0000 sec.
Longitude 112.00000 deg. 23.0 min. 26.0000 sec. Gps_loc .

Site_desc low flank of esker ridge

Topography undulating Slope_dir

Sfc_drain dry Sfc_veget present

Sfc_matl organics Cobbles & Boulders: 0% Size 0

Pit_no R7C Pit_depth 0.80 No_samples 2

Dpth_intvl 0.1-0.8

Princ_comp coarse sand

Usc_symbol gp

Other_comp gravel

Mx_gr_size

Fines few

Grading poor

Shape rounded

Texture

Colour

Moisture dry

Site_photo FM Video_t_p SH

Comments 1 cobble found @ 0.12 m

Prepared by Stephen Harrison

SITE AND SAMPLE DESCRIPTION SHEET

Site_no D 8 Pit_type D Date 07/22/94 Time 11:20

Latitude 64.00000 deg. 38.0 min. 42.0000 sec.
Longitude 112.00000 deg. 8.0 min. 27.0000 sec. Gps_loc .

Site_desc low flank of esker

Topography undulating Slope_dir

Sfc_drain dry Sfc_veget present

Sfc_matl organics Cobbles & Boulders: 0% Size 0

Pit_no D8D Pit_depth 0.60 No_samples 2

Dpth_intvl 0.1-0.6

Princ_comp sand

Usc_symbol sp

Other_comp silty, very little gravel

Mx_gr_size

Fines present

Grading poor

Shape

Texture

Colour lit. brown

Moisture dry

Site_photo FM Video_t_p SH

Comments

Prepared by Stephen Harrison

SITE AND SAMPLE DESCRIPTION SHEET

Site_no D 8 Pit_type G Date 07/22/94 Time 11:05

Latitude 64.00000 deg. 38.0 min. 40.0000 sec.
Longitude 112.00000 deg. 8.0 min. 33.0000 sec. Gps_loc .

Site_desc low flank of esker

Topography undulating Slope_dir

Sfc_drain dry Sfc_veget none

Sfc_matl coarse gravel Cobbles & Boulders: 0% Size 0

Pit_no D8G/C Pit_depth 0.80 No_samples 2

Dpth_intvl 0.1-0.8

Princ_comp medium sand

Usc_symbol sw

Other_comp some fines, very little gravel

Mx_gr_size l8

Fines present

Grading good

Shape rounded

Texture

Colour light grey

Moisture dry

Site_photo FM Video_t_p SH

Comments

Prepared by Stephen Harrison

SITE AND SAMPLE DESCRIPTION SHEET

Site_no D 9 Pit_type D Date 07/22/94 Time 12:35

Latitude 64.00000 deg. 39.0 min. 18.0000 sec.
Longitude 112.00000 deg. 9.0 min. 43.0000 sec. Gps_loc .

Site_desc low flank of esker

Topography undulating Slope_dir

Sfc_drain dry Sfc_veget present

Sfc_matl gravel Cobbles & Boulders: 0% Size 0

Pit_no D9D Pit_depth 0.70 No_samples 2

Dpth_intvl 0.25-0.7

Princ_comp fine sand

Usc_symbol sw

Other_comp silty

Mx_gr_size

Fines present

Grading good

Shape

Texture

Colour

Moisture dry

Site_photo FM Video_t_p SH

Comments

Prepared by Stephen Harrison

SITE AND SAMPLE DESCRIPTION SHEET

Site_no D 9 Pit_type G Date 07/22/94 Time 12:30

Latitude 64.00000 deg. 39.0 min. 16.0000 sec.
Longitude 112.00000 deg. 9.0 min. 35.0000 sec. Gps_loc .

Site_desc low flank of esker

Topography undulating Slope_dir

Sfc_drain dry Sfc_veget present but scarce

Sfc_matl gravel Cobbles & Boulders: 25% Size 800

Pit_no D9G/C Pit_depth 0.70 No_samples 2

Dpth_intvl 0.3-0.7

Princ_comp gravel

Usc_symbol gw

Other_comp sandy

Mx_gr_size 40

Fines present

Grading good

Shape rounded

Texture

Colour

Moisture dry

Site_photo FM Video_t_p SH

Comments unable to dig past 0.8 m due to sloughing of sand

Prepared by Stephen Harrison

SITE AND SAMPLE DESCRIPTION SHEET

Site_no D 10 Pit_type D Date 07/22/94 Time 15:40

Latitude 64.00000 deg. 36.0 min. 45.0000 sec.
Longitude 111.00000 deg. 30.0 min. 1.0000 sec. Gps_loc .

Site_desc low flank of esker

Topography undulating Slope_dir

Sfc_drain dry Sfc_veget present

Sfc_matl organics Cobbles & Boulders: 0% Size 0

Pit_no D10D Pit_depth 0.60 No_samples 2

Dpth_intvl 0.1-0.6

Princ_comp coarse sand

Usc_symbol sw

Other_comp some gravel

Mx_gr_size 20

Fines present

Grading good

Shape sub-rounded

Texture

Colour lit. brown

Moisture dry

Site_photo FM Video_t_p SH

Comments

Prepared by Stephen Harrison

SITE AND SAMPLE DESCRIPTION SHEET

Site_no D 10 Pit_type G Date 07/22/94 Time 15:15

Latitude 64.00000 deg. 36.0 min. 45.0000 sec.
Longitude 111.00000 deg. 30.0 min. 1.0000 sec. Gps_loc .

Site_desc low flamk of esker

Topography undulating Slope_dir

Sfc_drain dry Sfc_veget scattered

Sfc_matl organics Cobbles & Boulders: 5% Size 150

Pit_no D10GC Pit_depth 0.90 No_samples 2

Dpth_intvl 0.2-0.9

Princ_comp coarse sand

Usc_symbol sw

Other_comp some gravel

Mx_gr_size 60

Fines present

Grading good

Shape sub-rounded

Texture

Colour lit. brown

Moisture dry

Site_photo FM Video_t_p SH

Comments

Prepared by Stephen Harrison