GEOLOGICAL SURVEY OF CANADA

OPEN FILE 3081

Distribution and chemistry of kimberlite indicator minerals, Winter Lake map area (86A), Northwest Territories

D.E. Kerr, I.M. Kjarsgaard, B.C. Ward, L.A. Dredge, J.A.R. Stirling

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INTRODUCTION

Purpose

The Quaternary geology component of the Slave Province National Mapping Programme was designed to provide a regional framework for geologic interpretation, environmental management, and drift prospecting (Dredge et al., 1994a). In 1993, Terrain Sciences Division of the Geological Survey of Canada, mapped the surficial geology of Winter Lake, Lac de Gras and Aylmer Lake map areas (NTS 86A, 76D and 76C). The project involved helicopter-assisted ground work including terrain mapping at a scale of 1:60 000, till sampling, and measuring of ice flow indicators. For these three map areas a total of 194 10 kg till samples were collected from shallow pits for heavy mineral and gold grain analysis, and 500 additional smaller samples were analyzed for grain size and trace element geochemistry. In the Winter Lake map area approximately 117 till samples were collected for textural analysis and trace element geochemistry (Kerr et al., 1994a), 49 additional 10 kg till samples were collected for heavy mineral and kimberlite indicator analyses. This report documents the results from the electron microprobe analysis of potential kimberlite indicator minerals from the heavy mineral concentrates from these 49 samples; it also presents in general terms the results from the microprobe analysis for all three map areas. For the data pertaining to the other two map areas please refer to Open Files 3080 (Dredge et al., 1995) and 3079 (Ward et al., 1995).

The Winter Lake map area is located in the central Slave Province (Fig. 1). The area is currently the focus of diamond exploration and numerous diamondiferous kimberlites have been reported in the area (Pell, 1994). This study was undertaken to establish regional patterns and background values of kimberlite indicator minerals in an area of established kimberlites. It is hoped that results here can be used as references for future work in areas of kimberlite exploration in glaciated terrains.

LOCATION

The Winter Lake map area lies in the central District of Mackenzie, on the watershed of three major drainage systems. The first flows northwest via the Coppermine River; the second flows southeast via Winter River to Winter Lake and northwest via Snare River to Winter Lake, then southwest via Snare Lake. The third drainage system flows south via Yellowknife River. Numerous small lakes occupy glacially scoured bedrock basins, as well as isolated depressions in till plains. Most drainage ways are shallow; few streams and rivers have cut into bedrock or surficial sediments, with the exception of Snare River along which modest (2 to 4 m) river bank

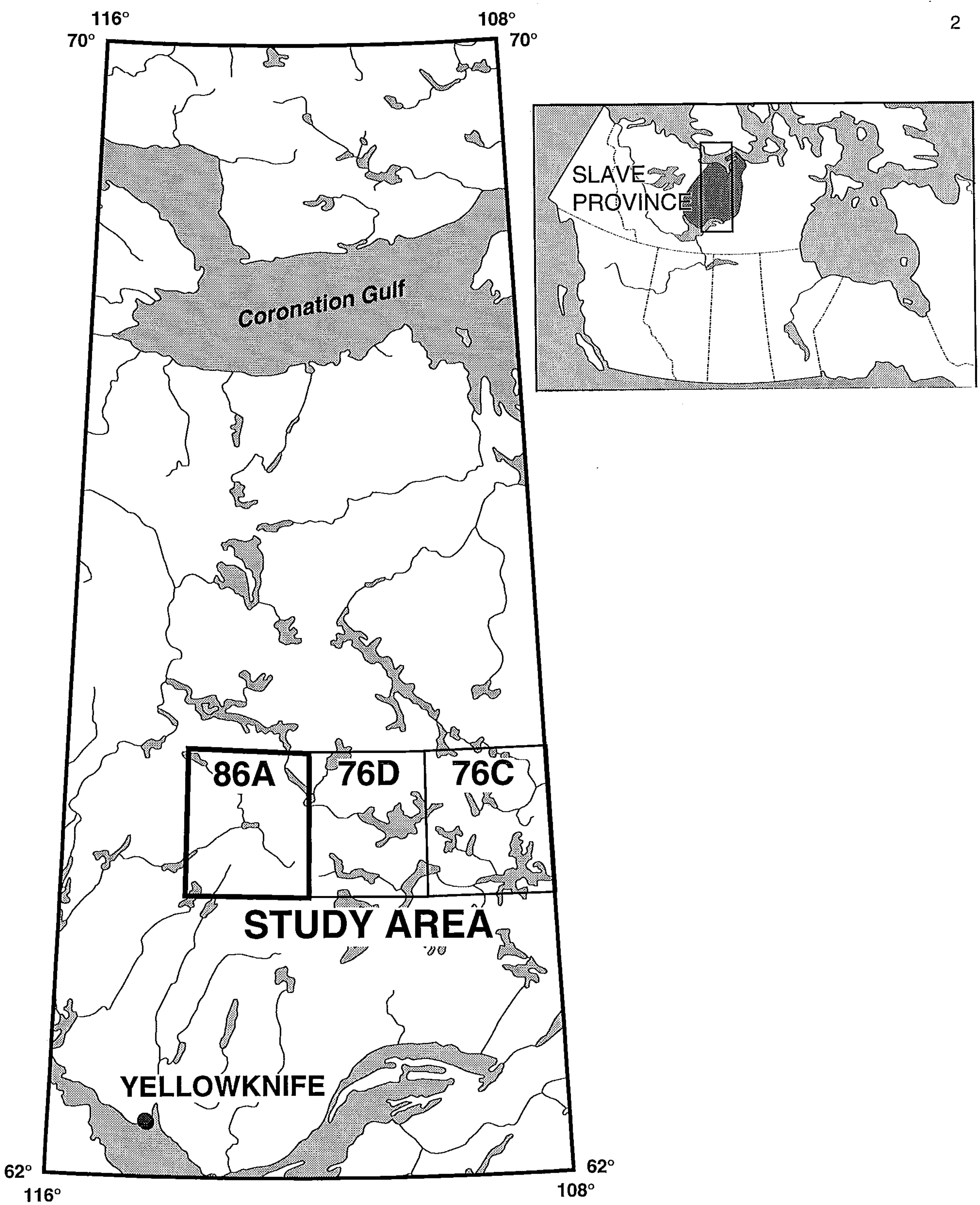


Figure 1 -Location map of study area.

sections occur. Elevations range between 355 m and 500 m. Local relief is variable, commonly between < 10 m and 30 m in areas of outcrop and till cover, although relief > 40 m is prevalent in rugged rocky areas in the southwest. The southwestern quadrant of the map area lies south of treeline. Regions north of this limit support sparse clumps of stunted spruce, birch, low shrubs, alder, and tundra heath vegetation.

REGIONAL GEOLOGY

Bedrock

The area lies within the central Slave Province of the Canadian Shield (McGlynn and Henderson, 1972: Padgham and Atkinson, 1991). Early references to bedrock, as well as to drumlins and eskers were made by Fry (1938) and Carroll (1939). Fraser (1958, 1969) mapped the bedrock and made general observations on striations, eskers and raised beaches. Hrabi *et al.*, (1993, 1994), Thompson *et al.*, (1993) and Thompson and Kerswill (1994) have mapped parts of the Winter Lake map area in more detail. The rocks consist primarily of Archean, subaquatically deposited (pillow) volcanics and related fine-grained turbidites belonging to the Yellowknife Supergroup. Sedimentary rocks are also present and have been folded, faulted, and metamorphosed to various degrees into phyllite, schist, gneiss, and migmatite. The metasediments were later intruded by granites which are the dominant rock type in the area. Sulphide mineralization has occurred along faults near sediment/volcanic contacts. Dyke swarms trending northeast, north and northwest occur throughout the area. No kimberlite pipes have been reported for the Winter Lake map area (Pell, 1994).

Most rock outcrops show signs of glacial abrasion, faceting and streamlining, but surfaces tend to be weathered or lichen covered. Glacial polish and striations are best preserved on small granite pegmatite bodies which are prevalent across the map area. All rock types have been subjected to postglacial frost shattering. Scattered frost-heaved blocks occur above the level of surrounding bedrock surfaces.

Surficial Geology

Nature of Deposits

Surficial geology of the Winter Lake Lac de Gras and Aylmer Lake areas has been mapped by Kerr et al., (1994b), Ward et al., 1994a and Dredge et al., (1994b), and aspects of the surficial geology of all three map areas are also available (Dredge et al., 1994a; and Ward et al., 1994b). Till is the most extensive deposit in the area.

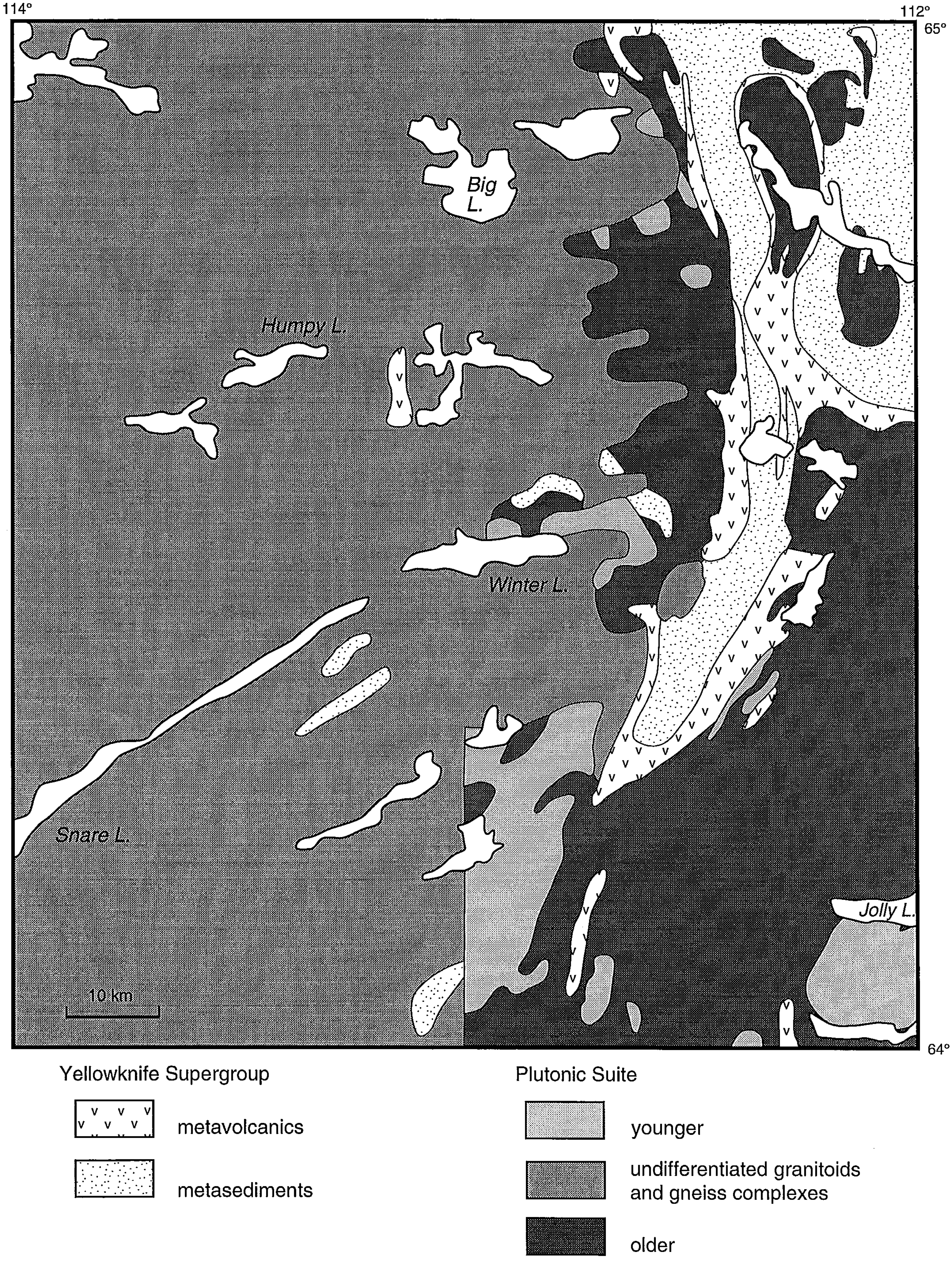


Figure 2: Simplified bedrock geology of the Winter Lake map are (modified afterThompson and Kerswell, 1994 and Fraser, 1969)

Only one stratigraphic unit of till has been recognized and is attributed to Late Wisconsinan Laurentide ice. The till sheet has been divided into 3 units based on thickness and surface morphology: veneer (thin), blanket (thick), and hummocky (variable but often thick). Till veneers and blankets are pervasive throughout the area. The till consists of a matrix supported diamicton, with the matrix ranging from silty sand to sand with low percentages of clay. The upper 0.5 to 1 m of the till has been extensively modified by cryoturbation and solifluction. Surficial organics have been incorporated to depths of 70-80 cm, and primary deposition features such as layers or lenses have commonly been cryoturbated.

Glaciofluvial deposits are geographically widespread but limited in extent and are predominantly in the form of eskers and related kames; proglacial outwash is very limited. Associated with the eskers are zones stripped to bedrock containing little if any surface sediment, commonly occurring on either side of large eskers or connecting esker segments.

Stream deposits (alluvium), the materials traditionally used to explore for kimberlite, are rare because the relief is low, and no major rivers flow through the area.

Glacial History

The area lies within the central part of the Keewatin sector of the Laurentide Ice Sheet (Dyke and Prest, 1987; Dyke and Dredge, 1989). The Winter Lake map area lies west of the M'Clintock Ice Divide, which was prominent during the Late Wisconsinan maximum (18 000 - 13 000 years BP). After 13 000 BP, the ice divide shifted eastward into the District of Keewatin, and Laurentide ice disappeared there about 7000 years ago. At its maximum, the northern margin of the Keewatin ice sheet extended north of the Arctic coast and as far west as the Mackenzie Valley. Radiocarbon dates on marine shells, beyond the boundaries of this map area to the north, suggest that ice still covered the area about 10 000 BP but that the ice margin lay 150-200 km east of Winter Lake by 9000 BP.

Ice flow indicators

Some aspects of the glacial history and the dominant direction of glacial transport can be determined by the relative age and strength of striations (Ward et al., 1994b). Figure 3 shows a summary ice flow diagram for all three map areas. For the Winter Lake map area, a more detailed sequence of events is shown in Figure 4. These data indicate that the dominant flow was to the west and northwest. Striae that trend southwest to the north of Big Lake may represent an earlier flow, which is widespread

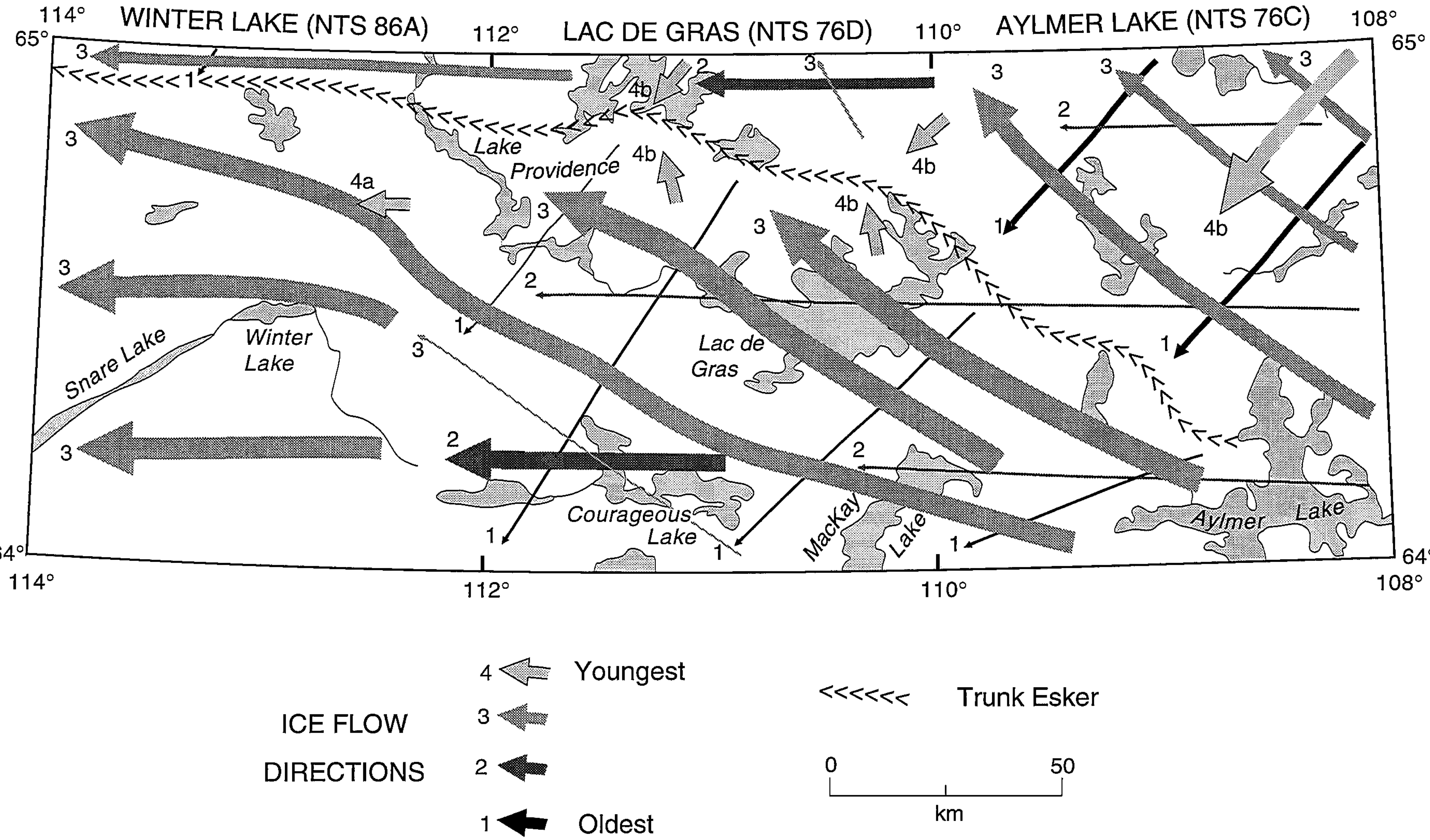


Figure 3: Summary ice flow for the three map areas studied. Glacial flow directions are numbered in order of decreasing age based on crosscutting relationships between striae. The thickness of each line indicates the relative influence of the flow on transporting debris and on modifying the landscape; the thickest arrows represent the dominant flow, responsible for most of the transport of glacial debris.

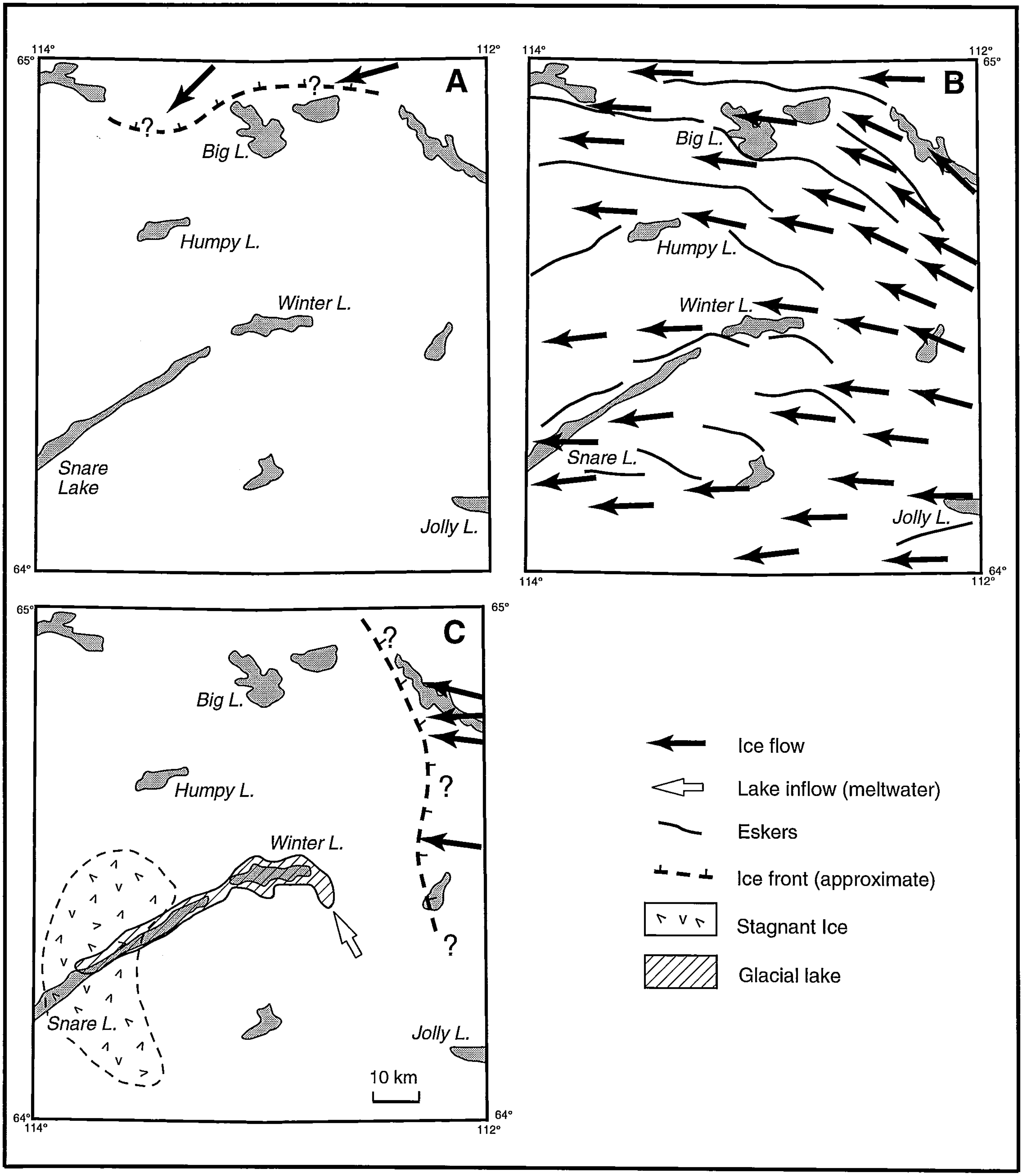


Figure 4: Sequence of ice flows that have affected the Winter Lake map area.

in the adjacent map area to the east (Dredge et al., 1994b; Ward et al., 1994a). However, this older southwest flow was not detected in most of the Winter Lake map area. Similarly, a final westward flow cross-cuts a major northwest flow to the west and south of Lake Providence and likely represents a late glacial event. All these striations probably represent the same, last glaciation because the surfaces they are found on are all relatively fresh (i.e., unweathered). Although dispersal trains from kimberlites will be affected by all these ice flows certain areas are more strongly affected by different flows. This is shown in Figure 3 by the width of the arrows. The widest arrows represent the dominant flow in an area; the flow most responsible for transport of till. It is likely that dispersal from kimberlites will be most strongly affected by the dominant flow in the area.

SAMPLE LOCATIONS

The location of till and esker samples are shown in Figure 5 and UTM coordinates are in Appendix 1. A total of 49 samples were taken.

METHODS

Sample Collection and Processing

All samples were taken from shallow hand dug pits. Almost all till samples were taken from mudboils from depths ranging from 20-80 cm. Attempts were made to sample unoxidized, relatively undisturbed material. No preconcentration was done in the field although an attempt was made to remove most of the pebbles (>2 cm) by hand.

Samples were processed at Overburden Drilling Management, Nepean, Ontario. Figure 6 is a detailed flow chart of the processing method for samples taken in 1993. In brief, a 10 kg split from the bulk sample was disaggregated and screened with the <1.0 mm fraction being run across a shaking table twice. The selected heavies were then separated by methylene iodine diluted with acetone at S.G. of 3.2. The ferromagnetic fraction was separated and stored and the nonferromagnetic fraction was sieved to <0.25, 0.25-0.5, and 0.5-1.0 mm. All fractions will be archived. For some samples that contained abundant indicator minerals the 1-2 mm fraction was also processed for heavy minerals directly by heavy liquids. The weights of all the different fractions are listed in Appendix 2.

Indicator Mineral Picking

For all samples the 0.25-0.5 mm fraction was sent to I. & M. Morrison Geological

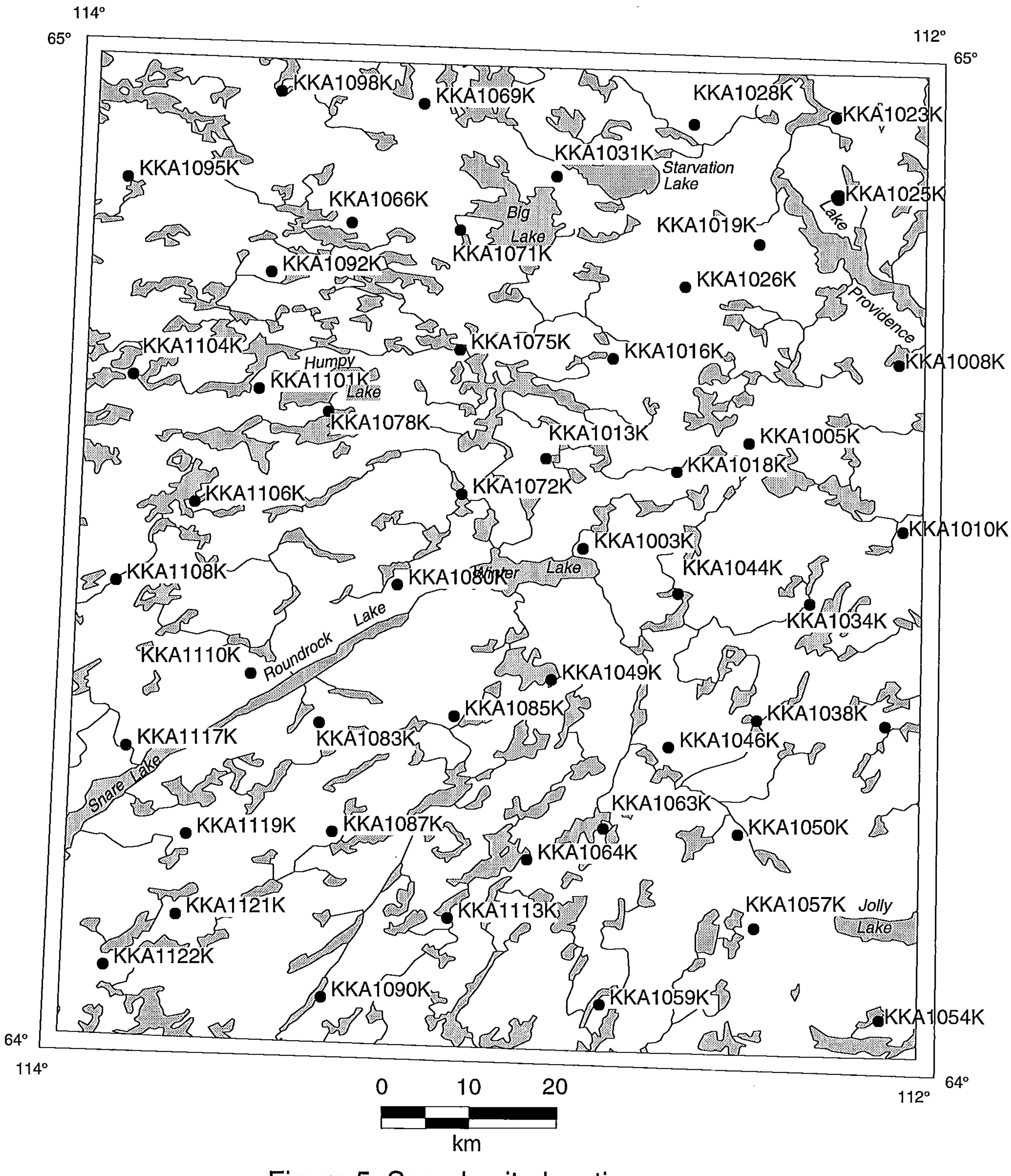


Figure 5: Sample site locations

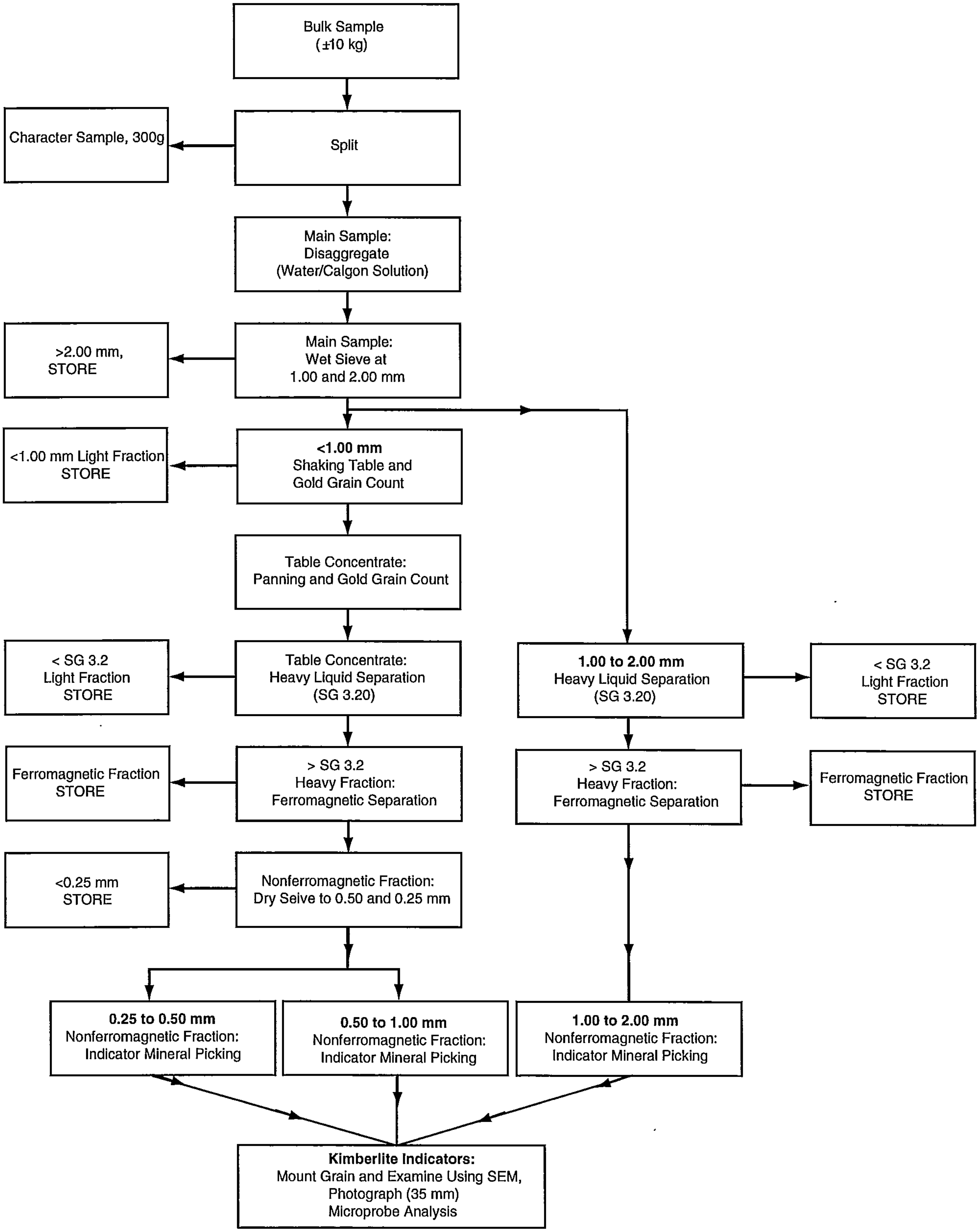


Figure 6 - Overburden Drilling Management Ltd. sample processing flow sheet for recovery of kimberlite indicator minerals and gold grains from till.

Indicator Mineral Picking

For all samples the 0.25-0.5 mm fraction was sent to I. & M. Morrison Geological Services, Delta B.C. for visual selection of potential kimberlite indicator minerals. Minerals included pyrope garnet, eclogitic garnet, chrome diopside, magnesian ilmenite and chromite. As well, pyrope grains that exhibited certain surface features such as kelyphite rims and resorption surfaces were noted. The 0.5-1.0 mm fraction was only picked for samples with 5 or more suspected pyropes in the 0.25-0.5 mm fraction. The 1.0-2.0 mm fraction was only picked for 1 samples, KKA1119 which had more than 5 pyropes in the 0.5-1.0 mm fraction. For all fractions picked the entire concentrate was examined.

Electron Microprobe Analysis

Potential kimberlite indicator mineral grains were mounted in 25 mm epoxy mounts and polished at Lakefield Research, Lakefield, Ontario. Color photographs and SEM images were taken of each epoxy mount to help identify each grain. The grains were analyzed using the electron microprobe facilities at the Geological Survey of Canada.

Analytical Methods

The analyses were done with a four spectrometer wavelength dispersive Cameca SX50 electron microprobe. The raw data were processed with the Cameca PAP program (Pouchou and Pichoir, 1984). Grains were analyzed in batches of 6 epoxy mounts with totals in excess of 700 grains, using automated runs of approximately 24 hours. The dead time correction formula (Willis, 1993) has been changed for this SX50 to achieve linearity at higher count rates.

The majority of the grains were analyzed using the "GARNET" routine. This routine was developed by the Geological Survey of Canada in order to analyze the major elements required to identify the potential mineral species to be encountered in this study using a minimum of probe time. The standards and operating conditions are given in Table 1. The calculated detection limits and counting times are given in Table 2.

Table 1. Operating conditions and standards for the major element routine "GARNET".

SUMMARY OF CONDITIONS IN GARNET.EXP AND GARNET.PHY

Cosecant of the take off angle: 1.556
Total number of elements : 11
Number of analyzed elements :10

CALIBRATION DATA :

	SPC	XTAL	POS.	+BG. OFFSET	-BG. OFFSET	BG SLOPE	PK-BG C/s/nA	SIGMA	PK_TIMs	%REQ. ACCUR.	BG_TIM ms
Na	1	PC0	26848	2500	-2500	0.00	1517.62	0.7	10	0.1	5000
K	3	PET	42757	1000	0	1.00	294.38	0.6	10	0.5	5000
Fe	4	LIF	48081	1050	0	1.00	333.18	0.3	10	0.1	5000
Mg	2	TAP	38516	1000	0	1.00	1155.93	0.2	10	0.1	5000
Si	2	TAP	27732	1500	0	1.00	1312.58	0.5	10	0.1	5000
Ca	3	PET	38389	2000	0	1.00	370.99	0.4	10	0.1	5000
Mn	4	LIF	52201	1200	0	1.00	435.75	0.2	10	0.5	4627
Ti	3	PET	31426	1000	0	1.00	803.96	0.1	10	0.1	5000
Cr	3	PET	26193	1000	0	1.00	366.95	0.1	10	0.1	5000
Al	2	TAP	32468	1000	0	1.00	1372.19	0.1	10	0.1	5000

STANDARD DATA:

	STD	WT	LINE	kV	BEAM
Na	NACL7	0.3930	Ka	20.0	20.0
K	KBR7	0.3290	Ka	20.0	20.0
Fe	MAG1	0.7236	Ka	20.0	20.0
Mg	MGO1	0.6032	Ka	20.0	20.0
Si	QTZ1	0.4674	Ka	20.0	20.0
Ca	WOL1	0.3432	Ka	20.0	20.0
Mn	MN	1.0000	Ka	20.0	20.0
Ti	RUT	0.5895	Ka	20.0	20.0
Cr	CHR1	0.2504	Ka	20.0	20.0
Al	COR1	0.5290	Ka	20.0	20.0

STANDARD DATA (CONT):

NACL7	Na	0.3930	Cl	0.6070								
KBR7	K	0.3290	Br	0.6710								
MAG1	Fe	0.7236	O	0.2764								
MGO1	Mg	0.6032	O	0.3968								
QTZ1	Si	0.4674	O	0.5326								
WOL1	Ca	0.3432	Fe	0.0030	Mn	0.0012	Si	0.2399	O	0.4127		
MN	Mn	1.0000										
RUT1	Ti	0.5895	Fe	0.0050	Nb	0.0050	O	0.4005				
CHR1	Cr	0.2504	Al	0.0762	Fe	0.2985	Mg	0.0434	Ti	0.0054	V	0.0012
	Mn	0.0015	Ni	0.0012	Si	0.0011	O	0.3211				
COR1	Al	0.5290	O	0.4710								

Table 2. Counting times for the sample and the calculated minimum detection limits (MDL) for the major element routine "garnet".

ELEMENT	TIME (s)	MDL (ppm)	MDL (oxide wt.%)
Na	10	300	0.040
Si	10	80	0.017
K	10	200	0.024
FE	10	400	0.051
AL	10	100	0.019
CA	10	200	0.028
MN	10	400	0.052
MG	10	200	0.033
TI	10	200	0.033
CR	10	200	0.029

Repeat analyses were carried out on various grains at irregular intervals throughout the study and the accuracy was found to be better than the natural chemical variation within the grain.

Mineral Identification

The analyzed grains were classified on the basis of their chemical composition. Theoretical chemical compositions of mineral endmembers (LeMaitre, 1982, Table

A13) were used to calculate cut-off values (at approximately 50:50 mol %) for members of binary solid solution series. These cut-off values are listed below. For analyses with low totals and for minerals that contain substantial amounts of more than two endmembers (which is the case for most garnets and spinels), these values were lowered accordingly. In equivocal cases molar fractions of the critical oxides were calculated in order to assess the endmember with the highest percentage, after which the mineral would subsequently be named. Additional information on the mineral grains (color, specific gravity, magnetic susceptibility) were used to improve or confirm identification.

Almandine	< 21 wt.% MnO <	Spessartine
Almandine	< 15 wt.% MgO <	**Pyrope**
Almandine	< 17 wt.% CaO <	Grossular
Andradite	< 11 wt.% Al_2O_3 <	Grossular
Andradite	< 2 wt.% TiO_2 <	Melanite
Pyrope	< 15 wt.% Cr_2O_3 + 17 wt.% CaO <	Uvarovite
Pyrope	< 2 wt.% Cr_2O_3 <	**Cr-Pyrope**
Andradite	< 2 wt.% Cr_2O_3 <	Cr-Andradite
LoCr-Diopside	< 1 wt.% Cr_2O_3 <	**Cr-Diopside**
Cr-Diopside	< 1.40 wt.% Cr_2O_3 <	**HiCr-Diopside**
Chromite	< Cr_2O_3/Al_2O_3 = 1.5 <	**Cr-Spinel**
Chromite	< 11 wt.% MgO + Cr_2O_3/Al_2O_3 <1.5 <	**Magnesio-chromite**
Chromite	< 3 wt.% TiO_2 <	**Ti-Chromite**
Rutile	< 15 wt.% FeO_{tot} <	Fe-Rutile
Ilmenite	< 6 wt.% MgO <	**Mg-Ilmenite**
Ilmenite	< 53 wt.% FeO_{tot} <	Ilmenite (altered)
Ti-Magnetite	< 18 wt.% TiO_2 <	Ilmenite (altered)
Hematite	< 2 wt.% TiO_2 <	Ti-Magnetite

In addition, prefixes were added to some of the indicator minerals (bold print) to highlight elevated contents of petrogenetically critical elements such as Mg, Cr, and Ti. Cutoff values for these prefixes (given in the table below) were chosen arbitrarily and might differ from those used by other authors. For instance, Cr-diopside was defined at >1 wt.% Cr_2O_3 while other authors have used a 0.5 wt.% Cr_2O_3 cutoff (Fipke, 1989; Thorleifson et al., 1994). Since the microprobe data is included in this report, users can reclassifiy the minerals according to their own criteria.

A problem in identifying and labeling the minerals properly was low totals in a few analysis caused by insufficient grain outcrop at the surface of the polished mount, inhomogeneities within the grain, or the presence of elements in the mineral not analyzed by the "GARNET" routine (eg. Zr, REE). In most cases, minerals could still be labelled in spite of low totals. Enlarged color prints as well as SEM backscatter images of the grain mounts were used to aid mineral identification and to recognize possible inhomogeneities, intergrowth or exsolutions within individual grains. Of 474 grains analyzed, only 3 could not be clearly identified, either because they represented a mixture of minerals or because their totals were too low.

RESULTS

A summary of the minerals found for each sample in the Winter Lake map area (86A) is given in Appendix 3. Microprobe analyses, sorted by sample number, are listed in Appendix 4. All probe data are also available on disk from the Geological Survey of Canada. A total of 474 mineral grains were analyzed and 60% were garnets, 11% were pyroxenes, 26% were ilmenites and the remaining 3% were other minerals and alteration products. The most important minerals are discussed below.

Garnet

Pyrope

A total of 285 garnets were identified and 228 of these were purple to reddish purple pyropes. They are chemically characterized by a high MgO content (>13 wt.% MgO) and varying amounts of Cr_2O_3 ranging from < 1 to up to 15 wt. %. Pyropes are exceedingly rare in upper crustal rocks and are found mainly in peridotites, kimberlites and lamproites (Deer, Howie and Zussman, 1982). They are therefore one of the most important kimberlite indicator minerals. Aside from crustal xenocrysts, garnets in kimberlite form three major petrogenetically and compositionally different groups: to purplish to rarely greenish peridotitic garnets (Ti-poor Cr-pyropes), orange megacryst garnets (Cr-poor, Ti-rich pyropes) and orange eclogitic garnets (titanian pyrope-almandine-grossular mixtures).

The composition of pyropes has been used to evaluate the diamond potential of kimberlites since diamonds are associated with Ca-poor, Cr-diopside free garnet harzburgite and group I eclogites (Gurney, 1984; Gurney and Moore, 1993; Fipke, 1989; McCandless & Gurney 1989). Pyropes from garnet harzburgite can be differentiated from other sources, including garnet lherzolite, by CaO vs Cr_2O_3 plots (Fig. 7). Kimberlites that contain pyropes in the harzburgite field (essentially "G10" garnets) are potentially diamondiferous (Gurney, 1984; Gurney and Moore, 1993; Fipke, 1989). Pyropes from the Winter Lake are study are shown in CaO vs Cr_2O_3 plots in Figures 8 and 9. Approximately 10-15% of these pyropes are subcalcic or "G10" garnets. These data indicate that most of the kimberlites represented by these samples have incorporated potentially diamondiferous harzburgitic mantle material. It is also apparent from Fig. 8 and 9 that no pyropes with $Cr_2O_3 < 2$ wt.% occur in this data set. This is suggestive of a lack of the Cr-poor pyropes which tend to be interpreted as megacrysts, implying that most of the pyropes were derived from mantle xenoliths (predominantly lherzolite, with minor harzburgite and wehrlite).

The TiO_2 vs Cr_2O_3 plot in Figure 10 reveals a continuous spectrum of Ti- and Cr-compositions within the pyropes, unlike other published data sets (Fipke, 1989; Thorleifson et al. 1994). This suggests either that megacrysts, if present in the area, were unusually Cr-rich and overlap completely with the peridotitic garnets, or that the peridotitic pyropes are unusually Ti-rich (compare Fig. 10, Schulze, 1995). If megacrysts are absent, it is unclear if this actually represents a lack of these garnets in kimberlites from this area or if they were excluded from selection due factors such as larger grain size or color.

Almandine-spessartine

The orange to red garnets of the almandine-spessartine series show a continuous spectrum of MnO compositions. MnO-rich almandines and spessartines are found mainly in pegmatitic and granitic rocks and their metamorphic equivalents (Deer et al., 1982) and are therefore of no interest to kimberlite prospection. They are, however, similar in appearance to eclogitic garnets, which are characterized by compositions between pyrope, almandine and grossular, with minor but diagnostic amounts of Ti and Na (McCandless & Gurney 1989; Schulze, 1995). They can be distinguished from crustal almandines in a triangular Mg-Ca-Fe plot (Fipke, 1989). Figure 11A shows one of these plots for all the almandine analyses for all three map areas (NTS 76C, 76D, 86A) as well as garnets from regional (NTS 76C, 76D, 86A) bedrock samples. Only two garnets fall into the field defined by analyses of garnets from diamondiferous eclogitic however several occur close to the boundary (Fipke, 1989). Figure 11B shows just the almandines from the Winter Lake map area with one

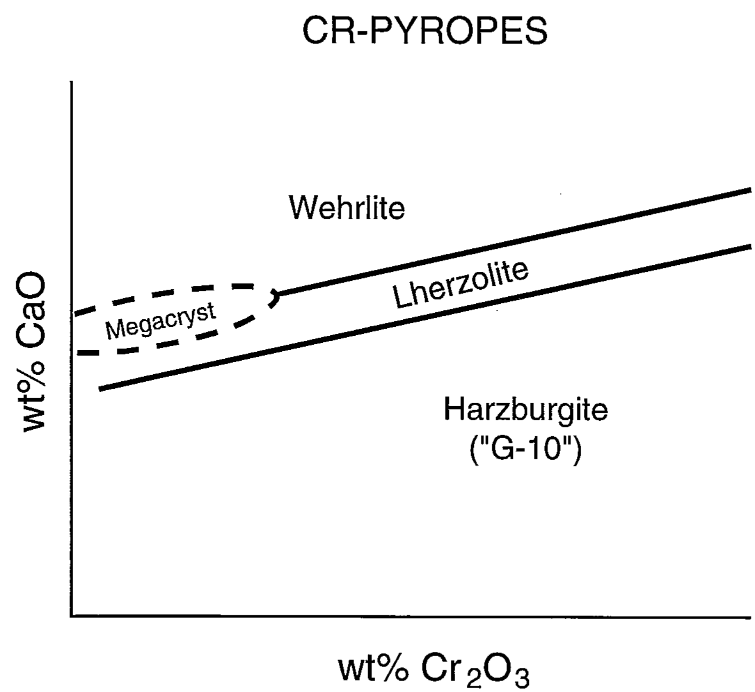
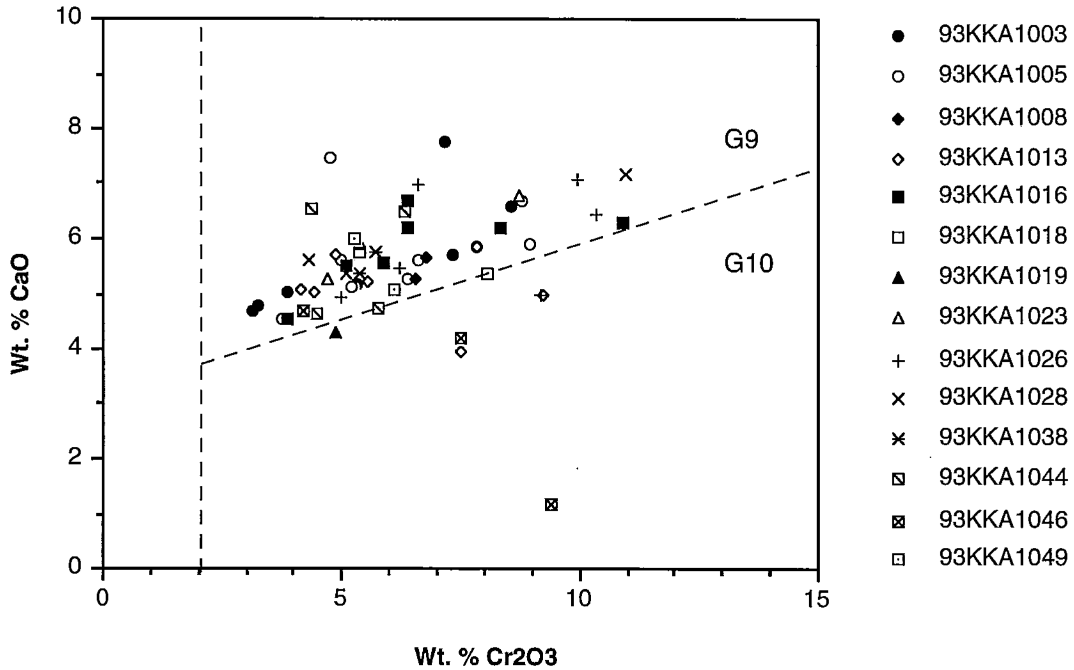


Figure 7: Stylized illustration of CaO and Cr_2O_3 ranges of garnet from various rock types likely to be sources of garnet xenocrysts and megacrysts in kimberlite (modified after Schulze, 1994).

Pyropes



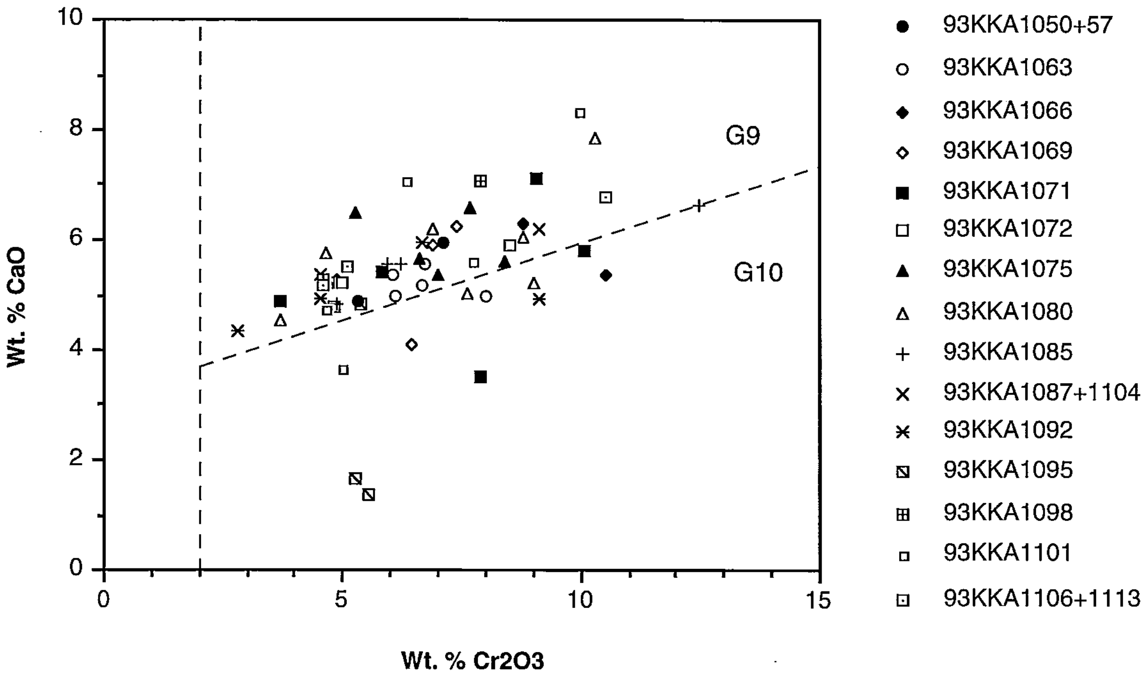


Figure 8: CaO vs Cr2O3 plot for pyropes. The diagonal line represents the break between lherzolitic and harzburgitic garnets. The vertical line marks the approximate break for Cr-poor megacryst garnets. Unless otherwise noted, samples are from the 0.25-0.5 mm fraction.

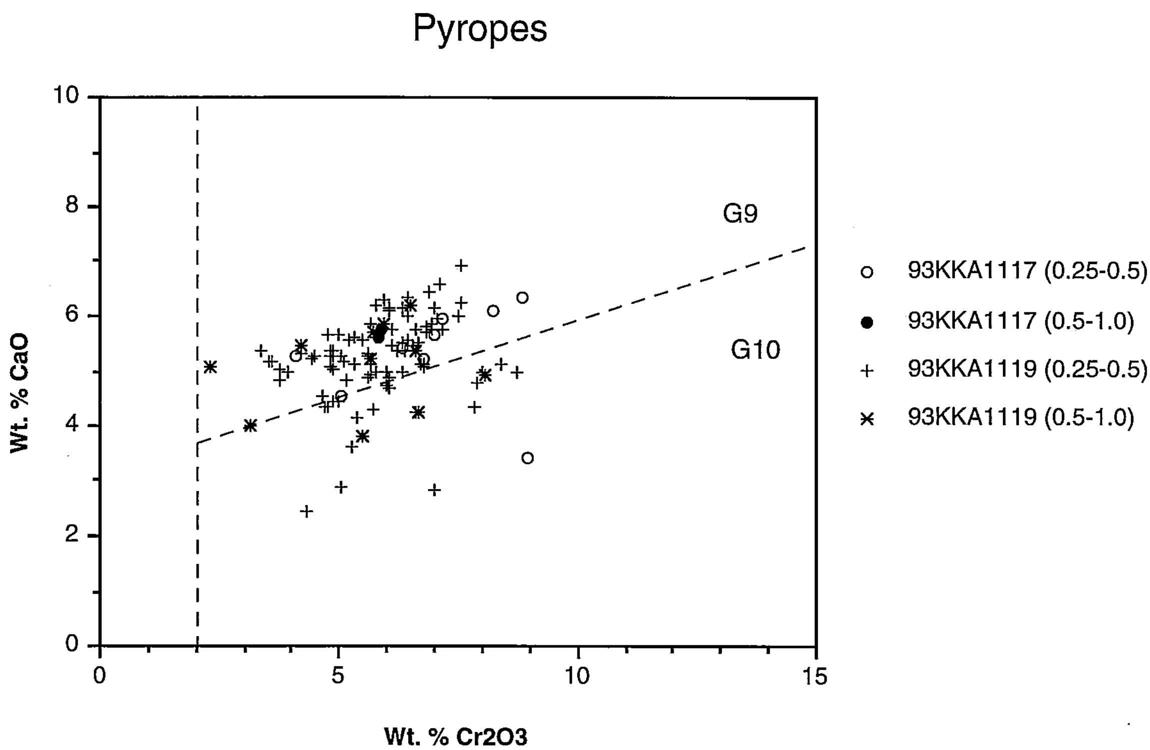


Figure 9: CaO vs Cr2O3 plot for pyropes. The diagonal line represents the break between lherzolitic and harzburgitic garnets. The vertical line marks the approximate break for Cr-poor megacryst garnets. Unless otherwise noted, samples are from the 0.25-0.5 mm fraction.

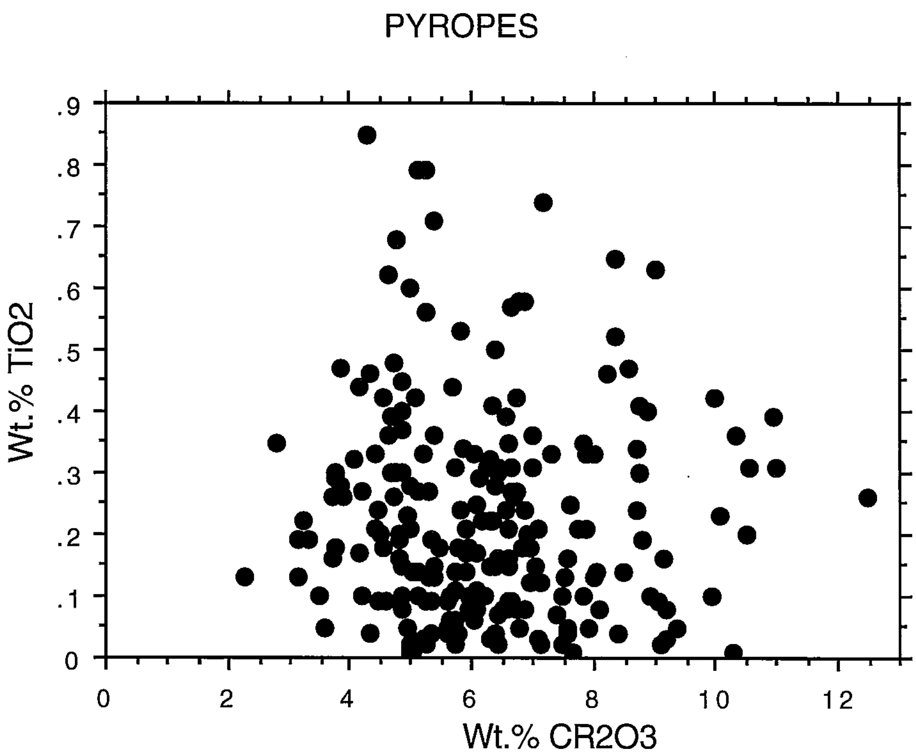
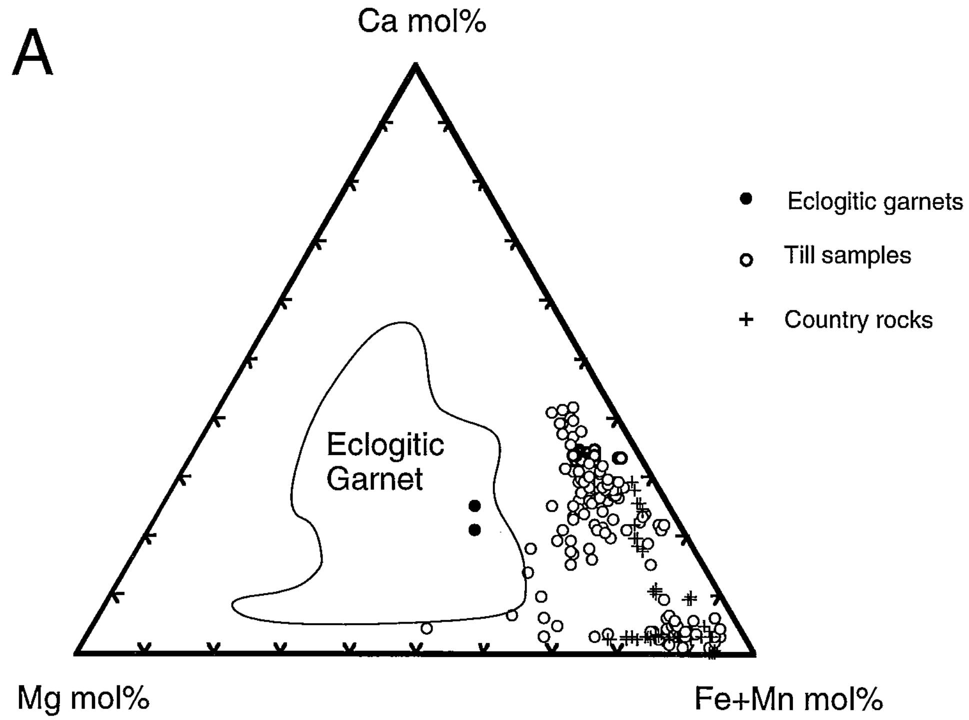


Figure 10: TiO_2 vs Cr_2O_3 plot for all pyropes in the Winter Lake map area.

Almandines



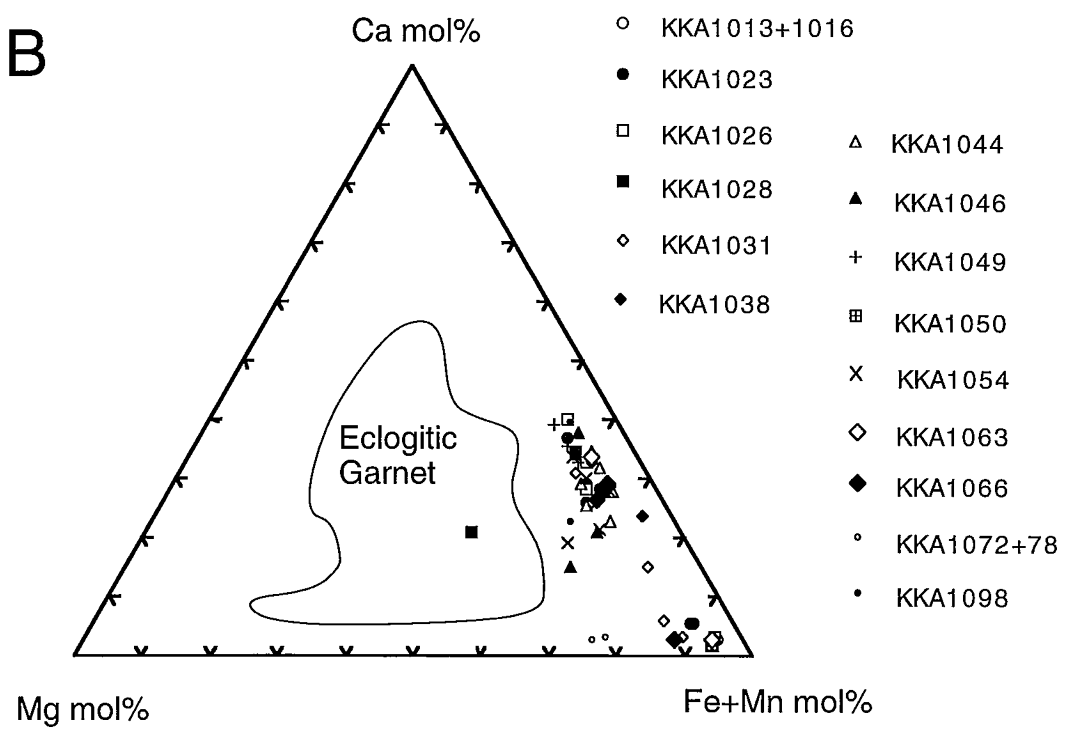


Figure 11- A. Triangular plot of Mg-Ca-Fe+Mn for almandines from till samples and local non-kimberlitic bedrock for all three map areas. Eclogitic garnet field is modified after Fipke (1989). Only two almandines found in till samples fall into the compositional field of garnets from diamondiferous eclogites, most others are similar to the crustal garnets analysed. B. Triangular plot of Mg-Ca-Fe+Mn for almandines from till samples from the Winter Lake map area.

almandine clearly falling in this zone from sample 93KKA1028.; however, its trace elements chemistry (TiO_2: 0.11 wt.%, Na_2O: 0.00 wt.%) does not appear diagnostic of eclogitic garnet

Other garnets

Other garnets identified were 1 orange and 1 green grossular and 1 green andradite. They were picked as potential orange eclogitic garnet or green chrome diopside.

Pyroxenes

A total of 54 diopsides were analyzed. Green chrome diopside is an important kimberlite indicator mineral, originating from mantle xenoliths (lherzolites and wehrlites) as well as megacrysts (clinopyroxene-ilmenite intergrowths). Kimberlites contain diopsides with a wide range of Cr_2O_3 values (up to 6 wt.%, Stephens and Dawson, 1977) which overlap at the lower end of the Cr_2O_3 spectrum with diopside compositions in other ultrabasic rocks (compare Table 52, Deer et al., 1978), making discrimination between kimberlitic and other diopsides on the basis of chrome content difficult. Studies of diopside compositions in till samples from the Kirkland Lake area (McClenaghan et al., 1993) have shown that diopsides with Cr-contents up to 1.4 wt.% can be found in varying abundances in samples that contain no other reliable kimberlite indicator minerals and thus could be derived from other sources. Based on a literature search, emerald green Cr-diopsides with high Cr_2O_3 (≥1.4 wt.%) are only found in mantle derived garnet peridotites and pyroxenites which can occur as xenoliths in ultrabasic magmas with deep mantle sources, (eg. kimberlites, and some lamproites) (Nixon, 1987), and in alpine peridotites and ultramafic intrusions (Deer et al., 1978). When there are no reported alpine peridotites or ultramafic layered intrusions, it is most likely that these Cr-diopsides are derived from kimberlites. Non-kimberlitic sources of Cr-diopsides in the study area exist in the form of small ultrabasic bodies in volcanic sequences (Thompson and Kerswill, 1994) and larger pyroxenites and layered basic intrusions to the east in the Aylmer Lake map area (Lord and Barnes, 1954).

We have therefore divided the diopsides into LoCr-diopsides (< 1.0 wt.% Cr_2O_3), which can originate in many rock types including kimberlite, Cr-diopsides (1.0 - 1.4 wt.% Cr_2O_3), which are probably from kimberlites and HiCr-diopsides (≥ 1.4 wt.% Cr_2O_3) which are most likely kimberlitic unless peridotitic bodies are present in the sampled area. It should be noted that these cutoffs, especially the 1.0 wt.% Cr_2O_3 are rather arbitrary and may change when the chrome contents of diopsides in kimberlites can be compared to those from other bedrock types in the area.

All these diopsides, LoCr, Cr and HiCr, can be considered kimberlite indicator minerals; however, with the LoCr-diopsides, especially those below 0.5 wt.% Cr_2O_3, if there are no other kimberlite indicator minerals present in the sample such as pyrope or Mg-ilmenite, it cannot be concluded that they originate from a kimberlite. Because of this uncertainty, we have not included LoCr-diopsides in our totals of indicator minerals. Two of the 33 LoCr-diopsides occur in 1 sample with no pyropes or Mg-ilmenite present; all 13 Cr-diopsides and 8 HiCr-diopsides occur in samples which also contained pyrope or Mg-ilmenite. The distribution of LoCr, Cr and HiCr-diopsides will be discussed in **Regional Trends.**

Ilmenite

Of 125 black ilmenites identified, the majority (118), were regional ilmenites from non-kimberlitic sources with MgO <6 wt.% (most were <3 wt.%). Mg-rich ilmenites with ≥6 wt.% MgO are characteristic for kimberlite (Mitchell, 1973; Haggerty, 1975): 7 of these Mg-ilmenites (also called picroilmenites) were identified. Analysis of Mg-ilmenites can yield information on the oxidation state of the kimberlite magma; high amounts of ferric iron in ilmenites indicate high oxygen fugacity which can cause the resorption of diamond during ascent of the magma (Gurney, 1989; Schulze, 1993). Ilmenites with low Fe^{3+}/Fe^{2+}, high MgO and Cr_2O_3, indicate that the potential for diamond resorption was low; conversely, ilmenites with higher Fe^{3+}/Fe^{2+} point towards more oxidizing conditions and a higher potential for diamond resorption (Gurney, 1989; Schulze, 1993). All the Mg-ilmenites from 76D are plotted in MgO vs Cr_2O_3 diagram in Figure 12. Samples with high MgO and Cr_2O_3 indicate good diamond potential. It should be noted that ilmenites in a given sample are not necessarily from the same kimberlite pipe but could have several kimberlite sources.

Leucoxene, Hematite and (Ti)-Magnetite

These black or grey Ti-Fe-rich oxides found in this study are mainly interpreted as alteration products of ilmenite. Leucoxene is not a pure mineral but a mixture of Fe- and Ti-rich phases (rutile, titanite and hematite). In this study the name leucoxene is used for non-stoichiometric mixtures of SiO2, FeO and TiO2 with minor Al2O3 and CaO. Grains consisting essentially of FeO and up to 30 wt.% TiO2 were tentatively labeled "Ti-magnetite". These grains were picked as potential Mg-ilmenites. Ti-magnetite is a solid solution of magnetite (FeFe2O4) and ulvöspinel (Fe2TiO4).

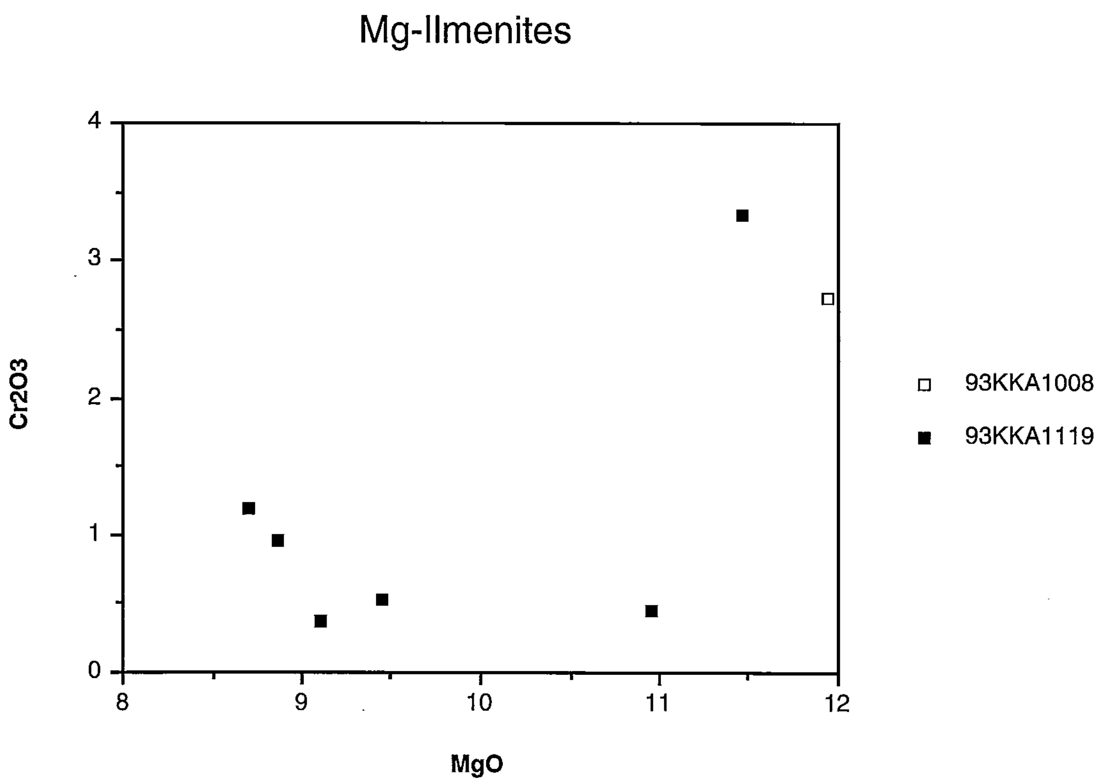


Figure 12: Cr2O3 vs MgO plot for all Mg-Ilmenites from the Winter Lake map area.

Natural Ti-magnetite, however, has TiO2 contents ≤ 18 wt.% (Deer, Howie and Zussman, 1962). The high TiO2 content and the unknown ratio of FeO/Fe2O3 of the grains identified here suggest that they are actually mixtures of ilmenite and hematite and not true Ti-magnetite but alteration products of ilmenite. Pure magnetite was not found in the samples since the ferromagnetic minerals were removed using a hand magnet before the samples were examined for indicator minerals.

Chromite

No chromites were identified in the Winter Lake map area.

Other Minerals

Other minerals analyzed in this study were usually picked because they resembled kimberlite indicator minerals: black amphibole, tourmaline and rutile were thought to be ilmenite or chromite and orange staurolite was thought to be eclogitic garnet.

KIMBERLITE INDICATOR MINERALS

Throughout the three map areas (76C, 76D, 86A), a total of 2273 indicator minerals (i.e. pyropes, diopsides >1 wt.% Cr_2O_3, Mg-ilmenites and chromites) were identified, of which 256 were from the Winter Lake map area. The following discussion pertains to the larger data set from the three map areas, which includes probe data from Dredge et al. (1995) and Ward et al. (1995), so that regional trends are established. This is then followed by a detailed discussion of the data from the Winter Lake area.

Regional Trends

Indicator Mineral Concentrations - Grain size factors

Total concentrations of indicator minerals ranged from 0 to >1000 grains per 10 kg sample. The majority of the indicator minerals were found in the 0.25-0.5 mm (35 to 60 mesh) size fraction (Fig. 13). In this fraction, 95 of the 194 samples contained indicator minerals confirmed by electron microprobe analysis (this excludes samples that only contained LoCr-diopsides). In the 0.5-1.0 mm (18 to 35 mesh) size fraction only 22 samples contained indicator minerals; however, not all samples had this fraction picked for potential indicator minerals. For samples taken in 1992 (none were taken in the Winter Lake map area) the O.5-1.0 fraction was picked if any potential

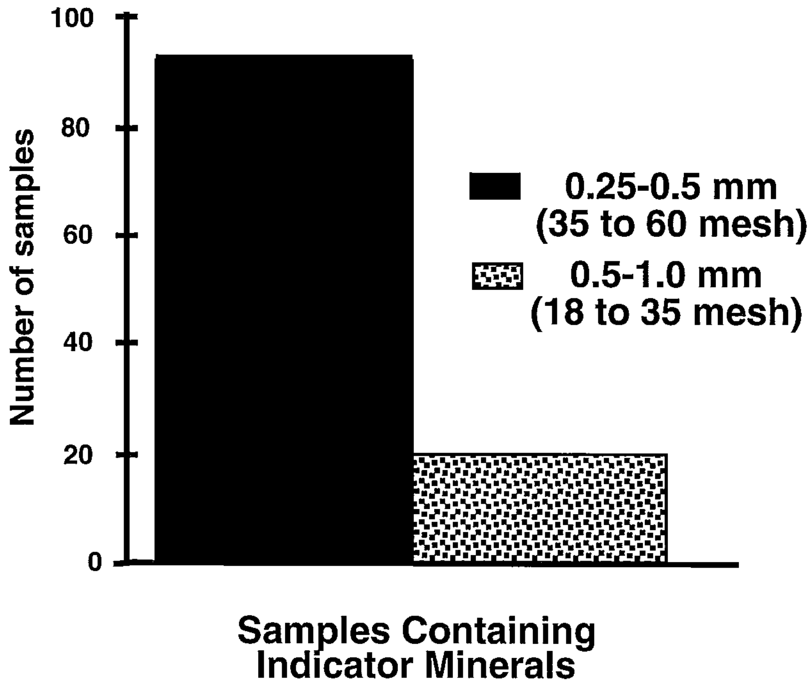


Figure 13: Number of samples for each size fraction examined that contained kimberlite indicator minerals.

indicator minerals were found in the 0.25-0.5 mm fraction. It was observed that many of the coarser fractions did not contain indicator minerals even if fairly large numbers of indicator minerals were found in the fine fraction. For samples taken in 1993, the 0.5-1.0 mm fraction was picked if at least 5 potential pyropes were found in the 0.25-0.5 mm fraction. Figure 14 shows a regression plot for the total number of kimberlite indicator minerals for the 0.5-1.0 mm fraction versus the number of pyropes in the 0.25-0.5 mm fraction. The y-intercept of the plot occurs well above 5 and we feel that for most samples where the 0.5-1.0 mm fraction was not picked would not have contained any indicator minerals. The difference in the concentration of indicator minerals between the two size fractions suggests that subtle anomalies will be missed if only the coarser grain size is examined. The use of the 0.25-0.5 mm size fraction will become increasingly important as exploration proceeds and all the more obvious dispersal trains have been discovered.

Indicator Mineral Concentrations - Mineral types

The relative proportion of indicator minerals for the entire data set is ~73% pyropes, ~24% Cr-diopsides, ~2% Mg-ilmenites, ~1% chromites and <<1% eclogitic garnets. Differences exist between the different size fractions in the proportions of the minerals (Fig. 15); however, since indicator minerals were only found in 22 samples of the 0.5-1.0 mm fraction, this could be non-representative. The results to date show a higher proportion of pyrope garnets in the 0.25-0.5 mm size fraction. This could be caused by the primary garnet size for the region or that pyrope garnet are fractured and break down easily. Fractures in pyropes were observed to be the cause of a similar distribution in the Kirkland Lake area (Averill and McClenaghan, 1994). A sample of weathered kimberlite obtained by the authors from the Torrie pipe, located just to the north of the Lac de Gras map area, was dissagregated without crushing. In the .5-1.0 and 1.0-2.0 mm fraction from this sample, the majority of pyropes were observed to contain abundant fractures which would likely result in rapid comminution during glacial transport.

Indicator Mineral Concentrations - Regional patterns

The regional distribution of kimberlite indicator minerals reveals variability in concentrations which strongly reflects the ice flow history and the principal zone of known kimberlites for the area (Fig. 16). Samples with the highest concentrations of

Regression Plot

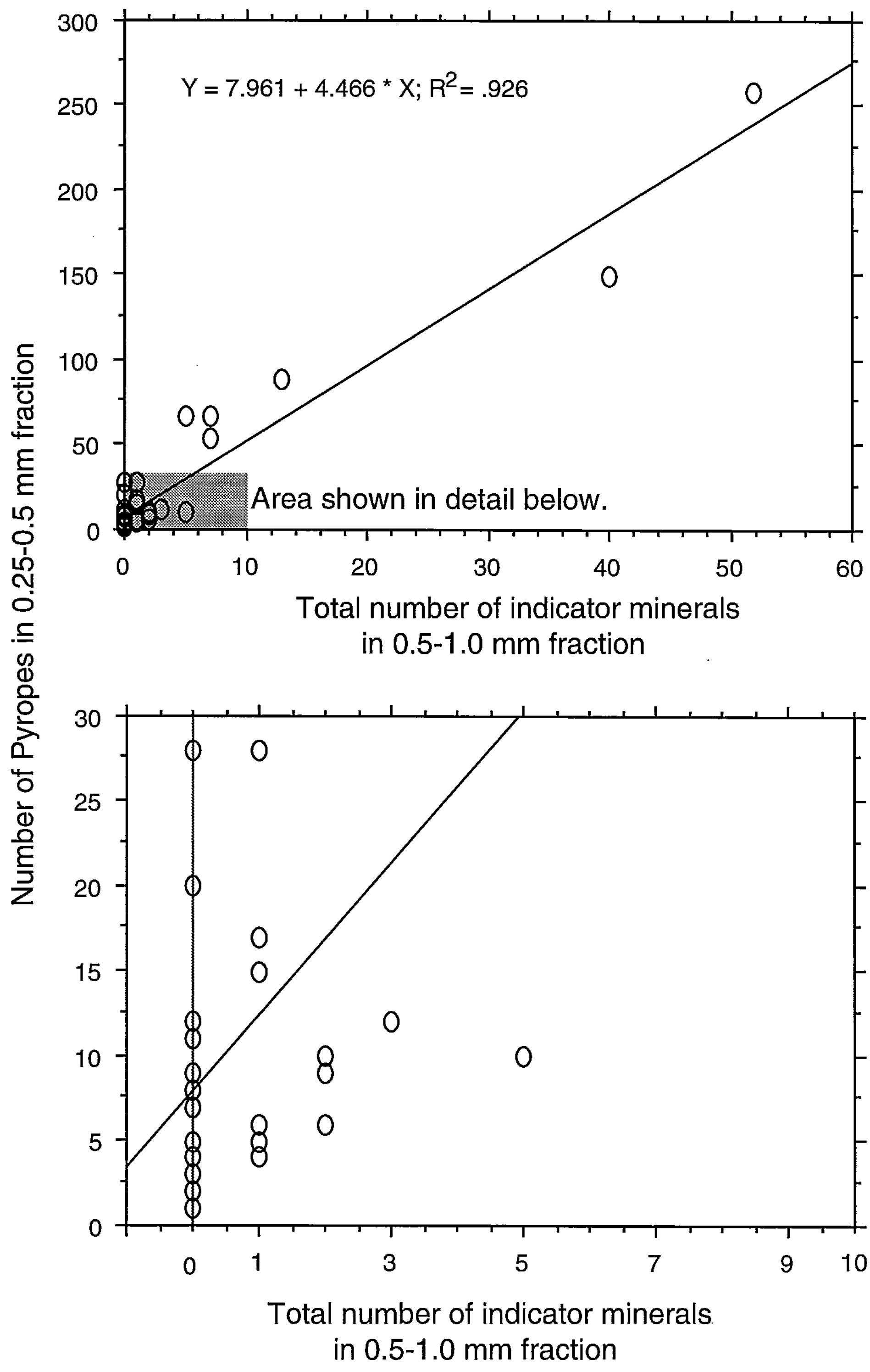


Figure 14: Regression plot of the total number of kimberlite indicator minerals for the 0.5-1.0 mm fraction versus number of pyropes in the 0.25-0.5 mm fraction.

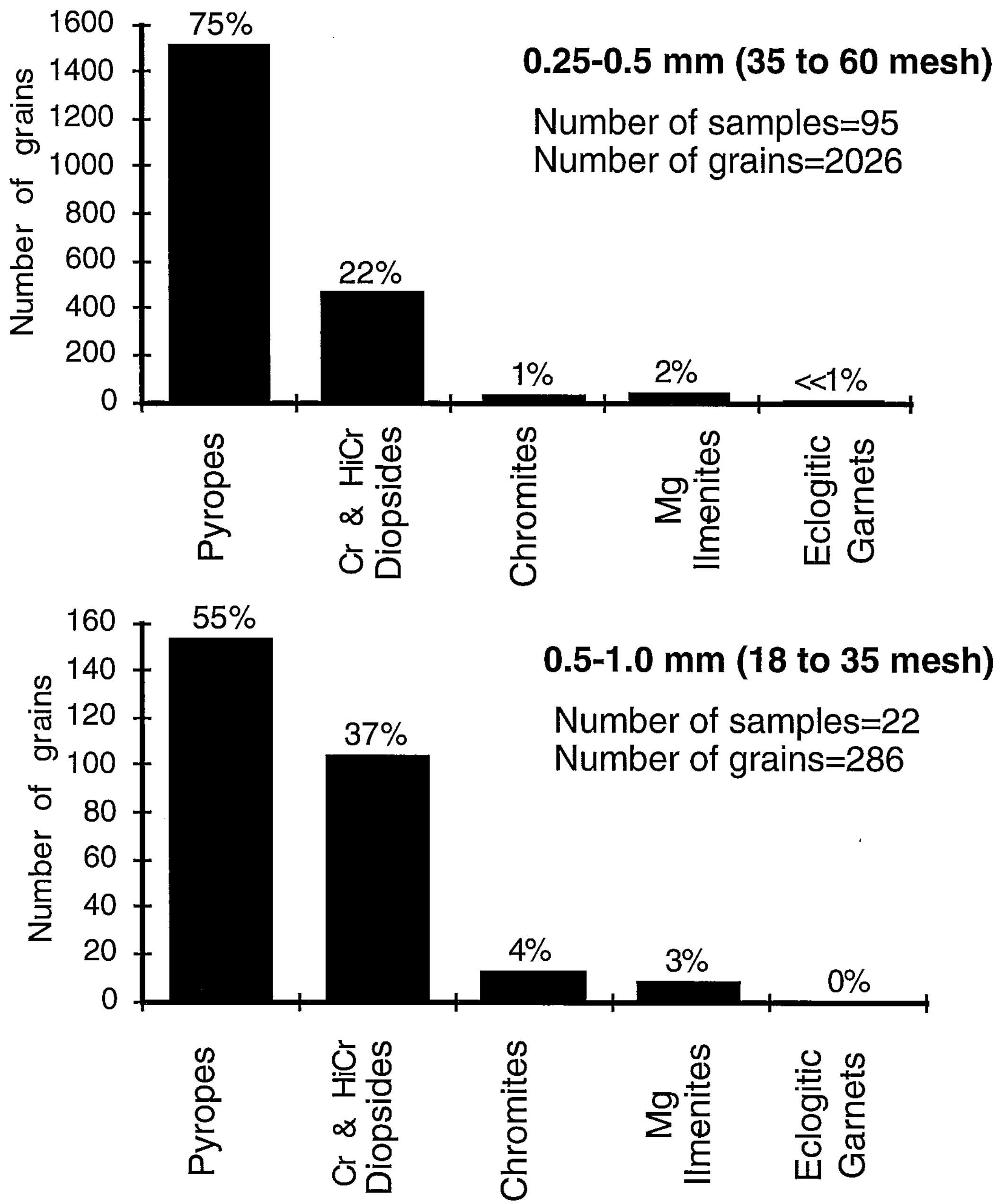


Figure 15: Proportion of minerals identified for the two size fractions examined.

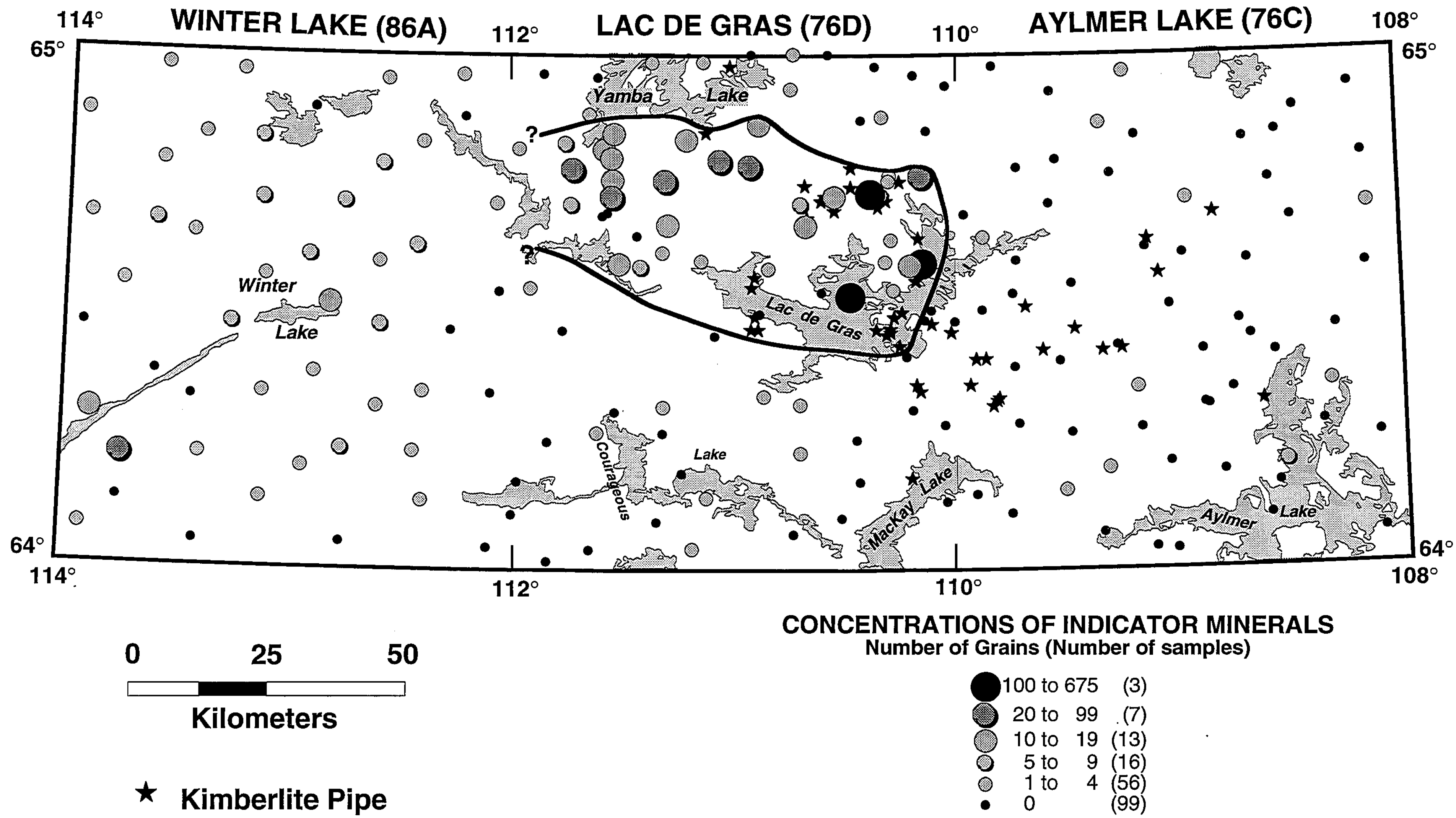


Figure 16: Distribution of kimberlite indicator minerals for the 0.25-0.5 mm fraction for all three map areas. The Lac de Gras dispersal plume is outlined in bold. Pipe locations are from Pell (1995).

indicator minerals occur in the northern half of the Lac de Gras (76D) map area, either adjacent to or down ice from known clusters of kimberlite pipes Abundant samples with low concentrations of indicator minerals occur in the Winter Lake (86A) map area; conversely, very few indicator minerals occur in the Aylmer Lake (76C) map area. Because of this distribution, what is considered a background or anomalous value of kimberlite indicator minerals varies throughout the region from map sheet to map sheet.

Based on the low sample density, the following background and anomalous values should be considered approximate. In the Winter Lake area, background values are high with most samples containing several indicator minerals; therefore, only samples with ≥7-10 indicator minerals would be considered anomalous. The sample to the southwest of Winter Lake, containing almost 100 indicator minerals, is clearly anomalous. The paucity of indicator minerals in the Aylmer Lake (76C) map area suggests that background values are near zero and any indicator minerals found in this area should be considered anomalous. The southern portion of the Lac de Gras map area also contains few indicator minerals, but because of the ice flow history of the area (Fig. 3), indicator minerals present could be from kimberlites to the west and northwest; therefore, samples containing >3 indicator minerals would be considered anomalous. Many of the samples in the northern portion of the Lac de Gras map area can be considered anomalous in the regional perspective but because the number of indicator minerals is highly variabe over a small area, determining what is anomalous is difficult; it is likely that ≥15-20 indicator minerals are anomalous in this area.

Although the sample density is low, the area with the highest concentration of indicator minerals is apparent based on the total number of indicator minerals (Fig. 16). As well, the distribution of pyropes defines a similar region (Fig. 17). This zone contains most of the samples with the highest concentrations of indicator minerals: only one sample with >10 pyropes occurs outside of it. This concentration is informally termed the Lac de Gras dispersal plume and likely represents the combined signature of the kimberlites to the north of Lac de Gras. The distribution of Cr and HiCr-diopsides do not define this zone as well as the pyropes; however, most of the samples within this plume contain HiCr-diopsides (Fig. 18). The northern limit of this plume generally corresponds to the location of the trunk esker for the region (Fig. 3); however, two samples, 93DU574 and 93DU583 with 28 and 10 pyropes respectively, lie a few kilometres to the north of this esker. The up ice (eastern) limit is apparently the southeast shore of Lac de Gras, even though there are kimberlites which occur to the

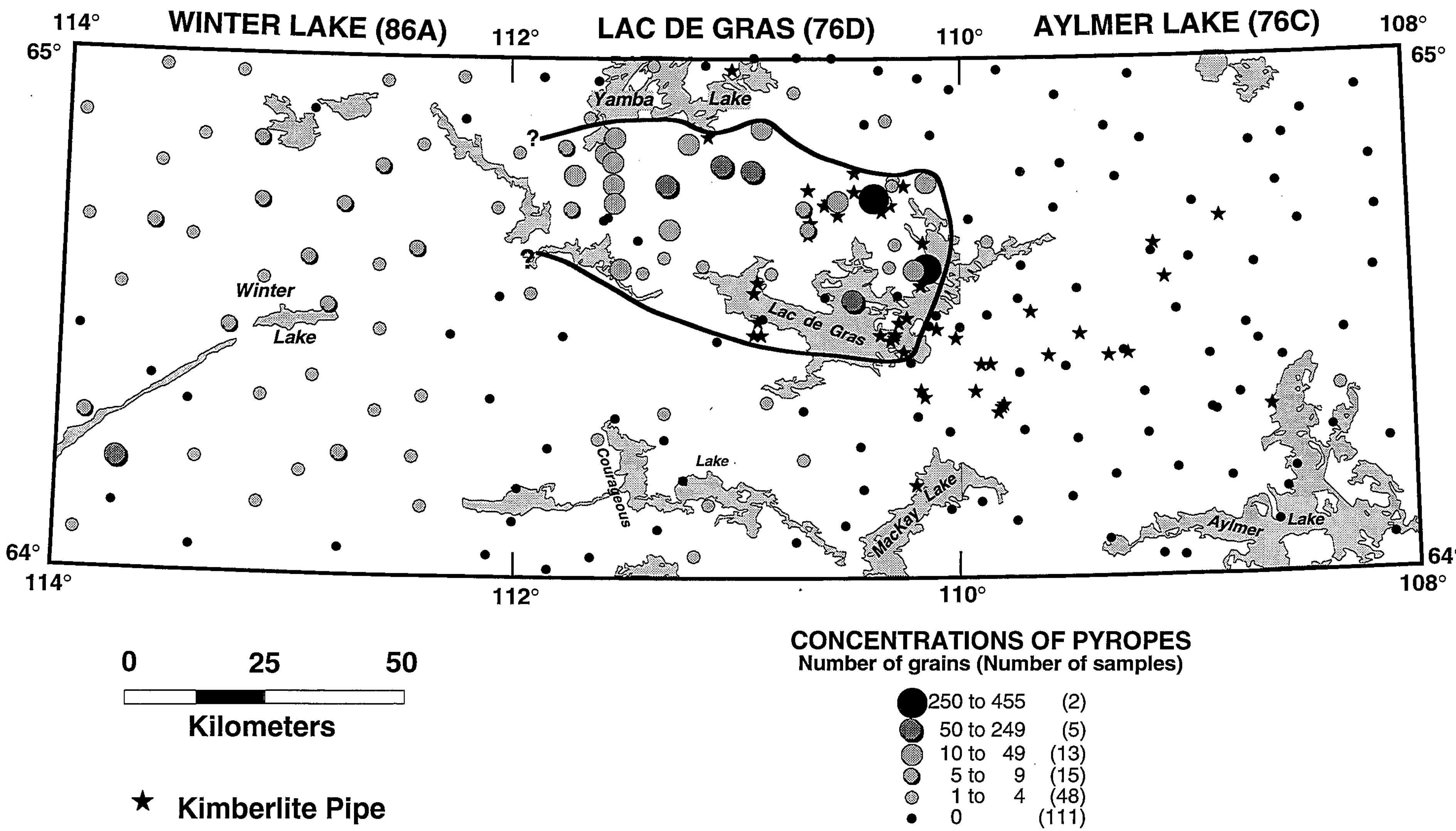


Figure 17: Distribution of pyropes for the 0.25-0.5 mm fraction for all three map areas. The Lac de Gras dispersal plume is outlined in bold. Pipe locations are from Pell (1995).

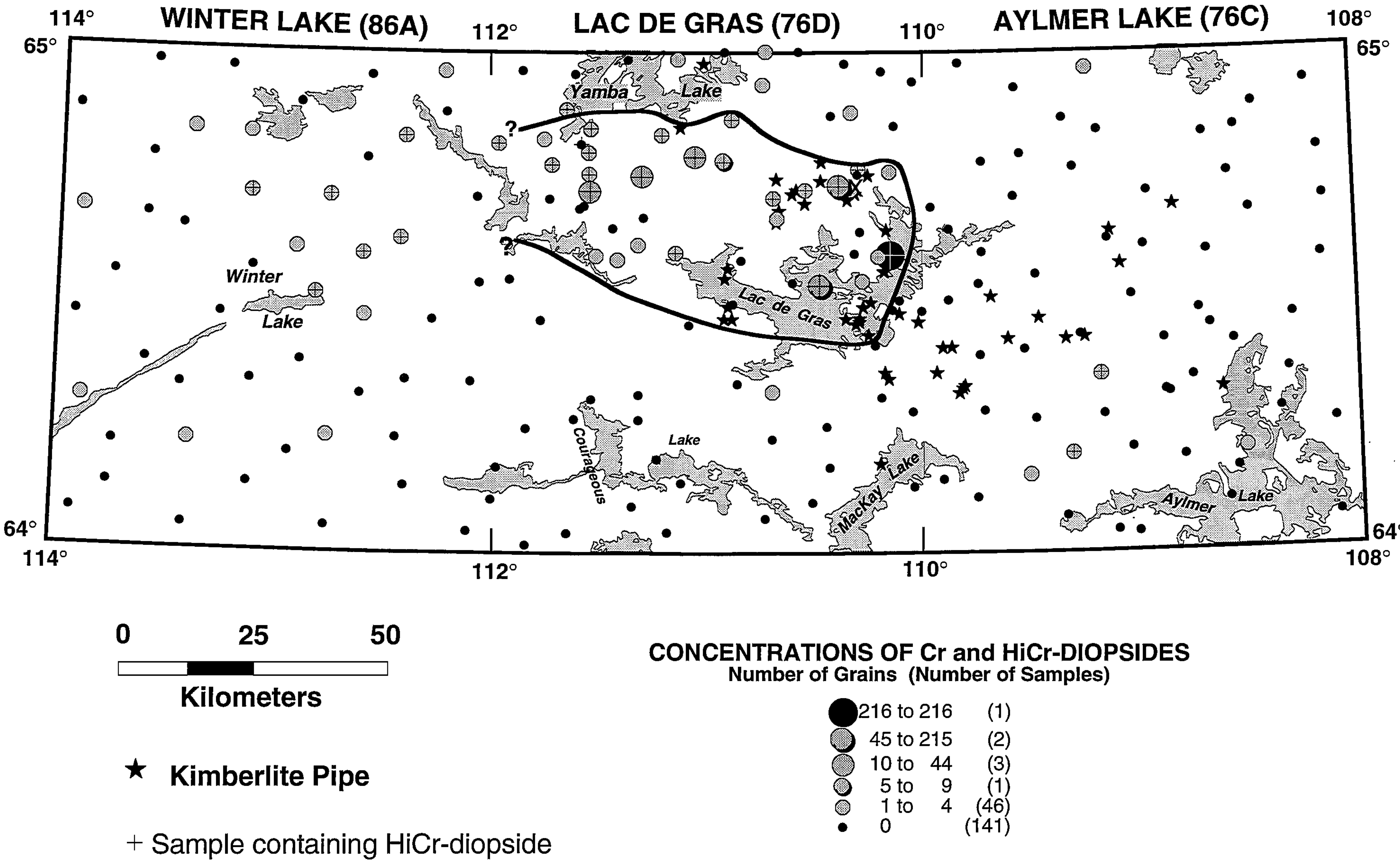


Figure 18: Distribution of the combined number of Cr and HiCr-diopsides for the 0.25-0.5 mm fraction. The Lac de Gras dispersal plume is outlined in bold. Pipe locations are from Pell (1995).

southeast of this. The southern limit is somewhat poorly defined because of sample density but would likely include the kimberlites on the southwest shore of Lac de Gras; these kimberlites are apparently recorded in sample 93BCW0036, 25-30 km downice. Within this plume almost all the samples contain indicator minerals: only 5 are barren. However, concentrations of indicator minerals are quite variable within relatively small distances. This variability is likely caused by the small size of kimberlites and the resulting small width of their dispersal trains. The plume appears to become indistinguishable from background values in the Winter Lake area after approximately 75 km.

The shape of the Lac de Gras dispersal plume can be explained by the glacial history of the area. Its elongate nature to the northwest reflects the dominance of northwestward glacial transport for the central portion of the Lac de Gras map area (Fig. 3). The trunk esker, which generally forms its northern boundary, also marks an interlobate position. It is unclear whether the two anomalous samples to the north of the trunk esker represent material transported from kimberlites to the south or material from kimberlites to the north of the trunk esker. Being an interlobate position, till from the plume was probably not transported very far to the north of the trunk esker. As well, any material that was transported to the north would have been remobilized and moved back towards the esker during deglaciation (Fig. 3).

The regional distribution of the indicator minerals also reflects the glacial history of the area. The abundance of samples with low concentrations of indicator minerals in the Winter Lake map area can be explained mainly by glacial dispersal from the Lac de Gras cluster; earlier phases of southwestward and westward flow (Fig. 3) could result in this diffuse dispersion. This would imply that many of the indicator minerals in this area could have undergone >150 km of glacial transport. The paucity of indicator minerals in the Aylmer Lake (76C) map area implies that there are fewer kimberlite pipes than in the Lac de Gras area; however, any indicator minerals found in this area would not be from kimberlites to the northwest of Lac de Gras since there is no record of eastward or southeastward ice flow.

Kimberlites to the southeast of Lac de Gras were not detected in the samples taken (Figures 16, 17 and 18). There are several possible explanations for this. Their concentration is not as great as northwest of Lac de Gras and, because of the low sample density, the individual dispersal plumes for these pipes may not have been identified. Another possibility is that these kimberlites have different heavy mineral suite signatures. Alternatively, due to the orientation of the surrounding local topography, they may not have been eroded by the northwestward flow, or possibly during one of the earlier ice flows, a thick cover of debris was laid down that prevented erosion by the northwestward flow.

There is some variation in distribution between the different types of indicator minerals. Only two pyropes were found in the Aylmer Lake (76C) map area, but 5 samples contained Cr-diopsides (>1% Cr_2O_3) with two of these samples containing HiCr-diopsides (>1.4% Cr_2O_3) (Fig. 18). These samples, especially those that contain HiCr-diopsides, likely reflect the presence of kimberlites, and the lack of pyropes implies that there are regional differences in kimberlite heavy mineral suites. This premise is supported by the sample with the highest concentration of indicator minerals in the Winter Lake (86A) map area since it contains mainly pyropes and no Cr-diopsides (Fig. 17). Figure 18 also shows samples with HiCr-diopsides. Samples containing these diopsides are concentrated in the Lac de Gras dispersal plume and other than the two samples from the Aylmer Lake map area, these samples also contain pyropes (Fig. 17). This appears to confirm that HiCr-diopsides are a fairly reliable kimberlite indicator mineral.

Figure 19 shows the distribution of LoCr-diopsides (<1.0 wt.% Cr_2O_3) and samples containing LoCr-diopsides with ≥ 0.5 wt.% Cr_2O_3 are also indicated. They are present in 94 samples, far more than any other indicator mineral. Throughout the Winter Lake and Lac de Gras map areas their distribution, especially those ≥0.5 wt.% Cr_2O_3, approximates, with some exceptions, that of pyropes. This correspondence and the fact that most of the samples from the Lac de Gras dispersal plume contain LoCr-diopsides implies that many of these diopsides, especially those ≥0.5 wt.% Cr_2O_3, are from kimberlite. However, many samples in the Aylmer Lake map area contain LoCr-diopsides and no other indicator minerals. It is unclear whether this reflects a difference in the heavy mineral suites for kimberlites in the area, as has already been suggested, or if these diopsides originate in other ultramafic rocks present. Further work is needed to refine cutoff values of chrome contents for kimberlite exploration in the area.

Distribution of Indicator Minerals-Winter Lake Map Area

A series of maps are displayed in Appendix 5 that show the distribution of indicator minerals for the different grain sizes examined. Arrows indicate the dominant

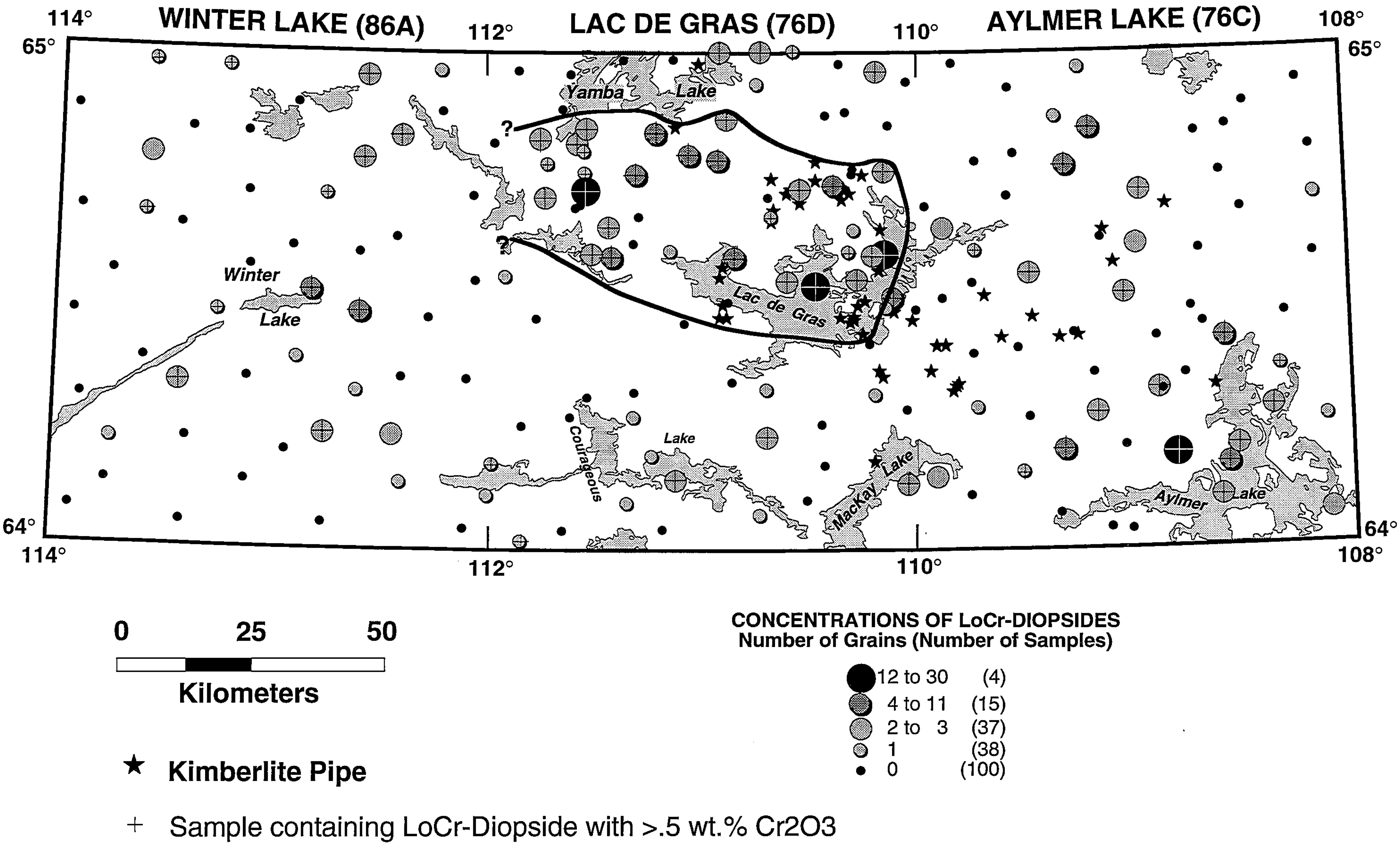


Figure 19: Distribution of LoCr-diopsides for the 0.25-0.5 mm fraction. The Lac de Gras dispersal plume is outlined in bold. Pipe locations are from Pell (1995).

ice flow directions throughout the area. A more detailed ice flow history is shown in Figure 4.

Map 5-1 shows the distribution of the total number of kimberlite indicator minerals for the 0.25-0.5 mm fraction. The concentration ranges from 0 to 92, with most of the samples containing at least 10 indicator minerals; 12 samples out of 49 are barren. The majority of samples with >5 indicator minerals occur in the northern portion of the map area and the majority of the samples that contain <3 indicator minerals occur to the south. This slightly higher concentration in the north reflects glacial dispersal from the Lac de Gras kimberlites resulting from the combined regional ice flow history (Fig. 3). The earliest flow would have transported material to the southwest of the Lac de Gras area and the subsequent shift to a westward and northwestward flow would have transported and dispersed this material over a broad region in the central and northern portion of the Winter Lake map area. However, samples 93KKA1119K (92 indicators) and 93KKA1117K (10 indicators) which are anomalous, cannot be easily explained by the glacial dispersal of Lac de Gras kimberlites and may be related to a more local source in the Winter Lake map area.

Map 5-2 shows the distribution of pyropes in the 0.25-0.5 mm fraction. The concentration ranges from 0 to 88 pyropes, with 12 barren samples. Most of the samples with 5 or more pyropes occur in the northern portion of the map area and most of the samples with two or less pyropes occur in the southern portion. Their distribution, similar to that of the total indicator minerals (Map 5-1), is the result of the regional ice flow history. Once again, sample 93KKA1119K with 88 pyropes is clearly anomalous.

Map 5-3 shows the distribution of the Cr and HiCr-diopsides (≥1.0 wt % and ≥1.4 wt %Cr_2O_3 respectively) for the 0.5 to 1.0 mm fraction. Samples which contain HiCr-diopsides are indicated; concentrations reach a maximum of 4 grains. HiCr-diopsides account for over half of all the diopsides shown on the map and these are all in the northern portion. Sample 93KKA1003K contains the highest number of Cr and HiCr-diopsides, as well as 6 pyropes. However, samples 93KKA1119K (88 pyropes) and 93KKA1080K (8 pyropes) contained no Cr or HiCr-diopsides. Compared to the Lac de Gras map area, Cr and HiCr-diopsides are much less abundant. This regional decrease could in part be due to differences in heavy mineral suites between kimberlites, but could also imply that Cr and HiCr-diopsides do not survive glacial transport as well as pyropes and are more easily broken down during transport.

Map 5-4 shows the distribution of Mg-ilmenites for the 0.25-0.5 fraction. The two samples containing Mg-ilmenites had counts of 1 and 4 grains. Sample 93KKA1119K, had the highest concentration of total indicator minerals and contained the greatest number of Mg-ilmenites; these minerals may be of local origin. The second sample, south of Lake Providence on the eastern border, may relate to the kimberlites of the Lac de Gras area.

Map 5-5 shows the distribution of all indicator minerals for the 0.5-1.0 mm fraction. Four samples contained 1 or 2 grains, but sample 93KKA1119K once again contained the highest concentration (13 grains). These samples generally correspond to samples that contained the highest number of indicator minerals in the 0.25-0.5 mm size class occurring predominantly in the northern half of the map sheet.

Maps 5-6, 5-7 and 5-8 show the distribution of pyropes, Cr and HiCr-diopsides and Mg-ilmenites respectively for the 0.5 to 1.0 mm fraction. Pyrope is the most common indicator mineral and its distribution is identical to that of total indicator minerals in this size class. Only one sample, 93KKA1016K, contained a Cr-diopside, and only one sample, 93KKA1119K, contained 2 Mg-ilmenites. As with the 0.25-0.5 mm fraction, no chromites were identified in the 0.5-1.0 mm fraction.

CONCLUSIONS

Kimberlite indicator minerals in till were examined in the Lac de Gras region across three 1:250 000 map areas to determine regional patterns and background values (this study; Dredge et al., 1995; Ward et al., 1995). The regional distribution of indicator minerals throughout the three map areas displays wide variability which can be explained by the ice flow history and the principal zone of known kimberlites for the area. The area with the highest concentration of indicator minerals occurs in the northern half of the Lac de Gras map area, either adjacent to or down-ice from most of the known kimberlites. The areas with the lowest concentrations of indicator minerals is the Aylmer Lake map area which is up-ice from most of the known kimberlites. Most samples from the Winter Lake map area contain at least a few indicator minerals. The ice flow history explains this diffuse, regional dispersion from the Lac de Gras kimberlites. Background values vary throughout the region from 0 in the Aylmer Lake area, to 7-10 in the Winter Lake area, to >15-20 in the northern portion of the Lac de Gras area. Differences in the distribution of kimberlite indicator minerals suggest differences in heavy mineral suites for different kimberlites.

The area with the highest concentrations of both the total number of indicator minerals and pyropes were used to informally define the Lac de Gras dispersal plume. This plume reflects the combined signature of all reported pipes in the region and indicates that till can be used as a regional exploration tool for clusters of kimberlite pipes. Its elongate nature to the northwest corresponds to the dominant direction of glacial transport. The northern boundary generally corresponds to the trunk esker in the area which occupied an interlobate position. Sample density was insufficient to define dispersal trains from individual kimberlites.

In the Winter Lake map area (86A) pyrope was the most common indicator mineral with decreasing concentrations of Cr-diopside (>1 wt.% Cr_2O_3) and Mg-ilmenite; no chromites were identified. Sub-calcic or "G10" garnets are common, comprising approximately 10-15% of all pyropes. The lack of a break between high-titanian and low-titanian pyropes raises the question of whether the peridotitic pyropes in the area are unusually titanium rich or whether megacryst garnets are absent. No eclogitic garnets were identified. Cr-diopsides (>1% % Cr_2O_3) and HiCr-diopsides (>1.4% Cr_2O_3) were differentiated and a greater probability of a kimberlite origin was assigned to the HiCr-diopsides. Mg-ilmenites were rare. Most indicator minerals were found in the 0.25-0.5 mm fraction compared to the 0.5-1.0 mm fraction.

The broad, regional dispersal of indicator minerals in the Winter Lake map area is the result of ice flow history. The northern regions, characterized by a greater number of indicator minerals than in the south, experienced a northwestward flow transporting material from the Lac de Gras kimberlites, as well as, material which was initially deposited immediately west and southwest of the Lac de Gras kimberlites by earlier ice flows. The more southern region of the Winter Lake area, with generally fewer indicator minerals, was glaciated by westward flowing ice from the southernmost Lac de Gras map area. This latter region likely contained fewer kimberlite indicator minerals to begin with, and the concentration of indicator minerals also likely decreased with increased distance down ice from their source to the north of Lac de Gras. This was compounded by the introduction of a greater quantity of local, relatively "barren" till from the southern Lac de Gras and Winter Lake map areas, resulting in a dilution effect.

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APPENDIX 1

UTM LOCATIONS OF SAMPLES

SAMPLE	EASTING	NORTHING	SAMPLE	EASTING	NORTHING
KKA1003K	413351	7155238	KKA1066K	386987	7192296
KKA1005K	432280	7167239	KKA1069K	395314	7205802
KKA1008K	449298	7176169	KKA1071K	399374	7191250
KKA1010K	449687	7157108	KKA1072K	399501	7161431
KKA1013K	409159	7165494	KKA1075K	399348	7177909
KKA1016K	416807	7176907	KKA1078K	384291	7170854
KKA1018K	424031	7163966	KKA1080K	392145	7151137
KKA1019K	433524	7189825	KKA1083K	383180	7135540
KKA1023K	442292	7204185	KKA1085K	398577	7136261
KKA1026K	425057	7185058	KKA1087K	384659	7123123
KKA1028K	426095	7203451	KKA1090K	383292	7104330
KKA1031K	410444	7197552	KKA1092K	377824	7186736
KKA1034K	439179	7148989	KKA1095K	361559	7197604
KKA1036K	447657	7135109	KKA1098K	379015	7207268
KKA1038K	433072	7135755	KKA1101K	376400	7173515
KKA1044K	424161	7150175	KKA1104K	362118	7175198
KKA1046K	423057	7132734	KKA1106K	369006	7160624
KKA1049K	409708	7140363	KKA1108K	360091	7151749
KKA1050K	430891	7122833	KKA1110K	375405	7141110
KKA1054K	446786	7101723	KKA1113K	397762	7113295
KKA1057K	432713	7112125	KKA1117K	361225	7133023
KKA1059K	415037	7103487	KKA1119K	367951	7122952
KKA1063K	415563	7123485	KKA1121K	366715	7113846
KKA1064K	406869	7119949	KKA1122K	358522	7108124
			KKA1025K	442538	7195169

APPENDIX 2

SAMPLE PROCESSING WEIGHTS

Abbreviations Used

M.I. = Methylene Iodine
N/S = not separated

Sample Number	Material	Amount Processed kg	>2 mm kg	1-2 mm kg	Table feed kg	M.I. Lights g	Total M.I. Concentrate g	Non-mag g	Non-magnetic fractions (mm) <0.25 g	0.25-0.5 g	0.5-1 g	1.0-2.0 g	Mag g
93KKA1003K	Till	10.00	2.15	0.55	7.30	317.0	52.1	42.9	33.4	7.2	2.3	N/S	9.2
93KKA1005K	Till	10.00	1.85	0.50	7.65	204.4	32.1	26.4	21.8	3.6	1.0	N/S	5.7
93KKA1008K	Till	10.00	2.45	0.70	6.85	189.3	25.6	17.8	13.7	3.2	1.0	N/S	7.8
93KKA1010K	Till	10.00	1.70	0.55	7.75	242.1	24.9	19.5	16.3	2.5	0.7	N/S	5.4
93KKA1013K	Till	10.00	1.20	0.65	8.15	409.0	35.2	26.0	21.1	3.6	1.3	N/S	9.2
93KKA1016K	Till	10.00	1.65	0.55	7.80	201.7	38.8	30.2	23.8	5.2	1.2	N/S	8.6
93KKA1018K	Till	9.90	1.80	0.55	7.55	218.6	25.3	20.4	16.2	3.2	1.0	N/S	4.9
93KKA1019K	Till	8.50	1.50	0.45	6.55	212.7	51.0	39.9	34.8	4.2	0.9	N/S	11.1
93KKA1023K	Till	10.00	1.90	0.80	7.30	217.3	45.7	37.5	30.8	5.5	1.2	N/S	8.2
93KKA1025K	Till	7.10	1.10	0.40	5.60	228.6	21.1	17.1	13.4	3.0	0.7	N/S	4.0
93KKA1026K	Till	10.00	1.80	0.60	7.60	258.6	28.9	19.7	15.7	3.2	0.8	N/S	9.2
93KKA1028K	Till	10.00	1.85	0.55	7.60	151.2	28.2	22.3	18.2	3.3	0.8	N/S	5.9
93KKA1031K	Till	10.00	2.40	0.80	6.80	187.9	40.8	28.3	22.8	4.6	0.9	N/S	12.5
93KKA1034K	Till	10.00	1.95	0.60	7.45	133.9	28.7	23.1	20.7	2.1	0.3	N/S	5.6
93KKA1036K	Till	10.00	1.10	0.45	8.45	191.1	16.1	11.7	9.8	1.5	0.4	N/S	4.4
93KKA1038K	Till	10.00	1.00	0.50	8.50	162.4	29.4	23.6	21.1	2.1	0.4	N/S	5.8
93KKA1044K	Till	10.00	2.25	0.80	6.95	304.7	31.7	24.8	20.0	3.5	1.3	N/S	6.9
93KKA1046K	Till	9.90	2.00	0.60	7.30	161.4	48.2	39.8	34.0	4.6	1.3	N/S	8.4
93KKA1049K	Till	10.00	1.25	0.45	8.30	139.7	30.9	25.1	20.7	3.6	0.8	N/S	5.8
93KKA1050K	Till	9.40	0.85	0.40	8.15	204.5	45.7	40.1	34.6	4.4	1.1	N/S	5.6
93KKA1054K	Till	10.00	0.85	0.45	8.70	257.2	39.4	30.2	26.2	3.1	0.9	N/S	9.2
93KKA1057K	Till	10.00	1.15	0.50	8.35	306.5	66.7	59.0	51.4	6.4	1.2	N/S	7.7
93KKA1059K	Till	10.00	0.90	0.40	8.70	208.0	43.0	36.7	31.2	4.8	0.7	N/S	6.3
93KKA1063K	Till	10.00	1.30	0.40	8.30	268.8	39.9	33.0	26.1	5.8	1.1	N/S	6.9
93KKA1064K	Till	10.00	1.35	0.45	8.20	244.0	62.8	51.7	44.4	5.8	1.5	N/S	11.1
93KKA1066K	Till	9.60	0.60	0.35	8.65	182.3	47.6	37.2	31.4	4.5	1.0	N/S	10.4
93KKA1069K	Till	10.00	1.45	0.45	8.10	237.3	58.5	47.4	39.0	6.7	1.7	N/S	11.1
93KKA1071K	Till	9.20	1.05	0.35	7.80	156.8	59.5	46.2	38.7	6.1	1.4	N/S	13.3
93KKA1072K	Till	10.00	4.35	0.70	4.95	250.3	58.5	49.0	36.0	11.2	1.8	N/S	9.5
93KKA1075K	Till	10.00	1.75	0.50	7.75	395.1	61.7	46.9	39.3	6.0	1.6	N/S	14.8
93KKA1078K	Till	10.00	1.45	0.50	8.05	458.4	53.5	37.3	29.5	6.6	1.2	N/S	16.2

Sample Number	Material	Amount Processed kg	>2 mm kg	1-2 mm kg	Table feed kg	M.I. Lights g	Total M.I. Concentrate g	Non-mag g	Non-magnetic fractions (mm) <0.25 g	0.25-0.5 g	0.5-1 g	1.0-2.0 g	Mag g
93KKA1080K	Till	10.00	0.90	0.30	8.80	363.0	80.5	66.0	55.9	8.2	1.9	N/S	14.5
93KKA1083K	Till	8.80	1.30	0.25	7.25	270.0	50.2	37.2	29.5	6.3	1.4	N/S	13.0
93KKA1085K	Till	10.00	0.85	0.40	8.75	252.0	63.8	38.7	33.9	4.0	0.8	N/S	25.1
93KKA1087K	Till	10.00	1.00	0.40	8.60	301.8	79.4	52.2	48.3	3.1	0.8	N/S	27.2
93KKA1090K	Till	7.80	0.65	0.25	6.90	212.9	35.9	27.4	24.5	2.9	0.2	N/S	8.5
93KKA1092K	Till	9.50	0.70	0.60	8.20	222.0	65.7	40.6	32.2	7.5	0.9	N/S	25.1
93KKA1095K	Till	10.00	1.10	0.50	8.40	392.1	66.2	47.8	41.5	5.6	0.7	N/S	18.4
93KKA1098K	Till	10.00	1.10	0.40	8.50	271.0	46.4	35.5	29.1	5.5	0.9	N/S	10.9
93KKA1101K	Till	9.30	1.05	0.40	7.85	218.0	46.3	31.2	24.8	5.1	1.3	N/S	15.1
93KKA1104K	Till	10.00	1.35	0.70	7.95	180.3	48.3	28.9	24.6	3.5	0.8	N/S	19.4
93KKA1106K	Till	8.50	2.45	0.50	5.55	171.8	69.4	49.3	32.5	11.7	5.1	N/S	20.1
93KKA1108K	Till	9.30	2.35	0.50	6.45	210.5	35.1	27.1	21.0	5.1	1.0	N/S	8.0
93KKA1110K	Till	8.70	3.80	0.85	4.05	162.9	31.8	20.4	15.9	4.3	0.2	N/S	11.4
93KKA1113K	Till	9.20	1.70	0.60	6.90	145.6	28.9	22.5	18.3	3.5	0.7	N/S	6.4
93KKA1117K	Till	10.00	1.05	0.70	8.25	220.0	167.3	95.2	83.4	10.2	1.6	N/S	72.1
93KKA1119K	Till	8.25	0.30	1.55	6.40	285.1	21.6	13.5	10.0	2.4	1.1	N/S	8.1
93KKA1121K	Till	7.70	1.00	0.35	6.35	83.0	38.4	25.5	22.3	2.7	0.5	N/S	12.9
93KKA1122K	Till	9.65	0.00	0.09	9.56	204.7	87.8	69.2	65.2	3.7	0.3	N/S	18.6

APPENDIX 3

SUMMARY OF MINERALS IDENTIFIED FOR ALL SAMPLES

Abbreviations Used
Pyr = Pyrope
Alm = Almandine
Spe = Spessartine
Gro = Grossular
And = Andradite
Stau = Staurolite
HCD = HiCr-Diopside
CrDi = Cr-Diopside
LCD = LoCr-Diopside
Amph = Amphibole
Tou = Tourmaline
Hm = Hematite
Rut = Rutile
FeTi = FeTi-Oxide
Ilm = Ilmenite
MgIl = Mg-Ilmenite
Chr = Chromite
Spi = Spinel
Mt = Ti-Magnetite
? = Mineral not identified
X = missed grain

Sample	Size(mm)	Total	Pyr	Alm	Spe	Gro	Mel	And	Stau	HCD	CrDi	LCD	Amph	Tou	Hm	Rut	FeTi	Ilm	MgIl	Chr	Spi	Mt	?	*	x	Total	KIM	Remarks
93KKA1003	.5-1.0	3	2			1																				3	2	
93KKA1003	.25-.5	19	6							2	2	4						5								19	10	
93KKA1005	.25-.5	13	8		1					1								3								13	9	
93KKA1008	.25-.5	8	2															5	1							8	3	
93KKA1010	.25-.5	2	0			1												1								2	0	
93KKA1013	.5-1.0	2																2								2	0	
93KKA1013	.25-.5	32	7	1							1							23								32	8	
93KKA1016	.5-1.0	2	1								1															2	2	
93KKA1016	.25-.5	13	6	1						1	1	1						3								13	8	
93KKA1018	.25-.5	7	2							2								3								7	4	
93KKA1019	.25-.5	5	2							1		2														5	3	
93KKA1023	.25-.5	17	1	6							1	1						8								17	2	
93KKA1026	.5-1.0	1	1																							1	1	
93KKA1026	.25-.5	17	5	3	2							2						5								17	5	
93KKA1028	.25-.5	14	3	2								2						6				1				14	3	
93KKA1031	.25-.5	6	0	6																						6	0	
93KKA1034	.25-.5	2														1		1								2	0	
93KKA1038	.25-.5	6	2	2			1											1								6	2	
93KKA1044	.25-.5	18	4	6							1	5											1	1		18	5	*Hedenbergite
93KKA1046	.25-.5	9	3	5								1														9	3	
93KKA1049	.25-.5	8	2	3								1						2								8	2	
93KKA1050	.25-.5	12	1	5								2						4								12	1	
93KKA1054	.25-.5	4		2									1					1								4	0	
93KKA1057	.25-.5	5	1									1						3								5	1	
93KKA1063	.25-.5	15	5	2							1	2						5								15	6	
93KKA1064	.25-.5	1	1																							1	1	
93KKA1066	.25-.5	11	3	3							1		1					2					1			11	4	? = Monazite ?
93KKA1069	.25-.5	4	3									1														4	3	
93KKA1071	.25-.5	6	5								1															6	6	
93KKA1072	.25-.5	5	4	1																						5	4	
93KKA1075	.25-.5	13	5							1								7								13	6	
93KKA1078	.25-.5	8	2	1														5								8	2	
93KKA1080	.25-.5	9	8									1														9	8	
93KKA1083	.25-.5	6										2						4								6	0	
93KKA1085	.25-.5	5	4																				1			5	4	
93KKA1087	.25-.5	2	1								1															2	2	
93KKA1092	.25-.5	8	4									2						2								8	4	
93KKA1095	.25-.5	3	3																							3	3	
93KKA1098	.25-.5	8	2	2								1						3								8	2	
93KKA1101	.25-.5	7	5									1						1								7	5	

Sample	Size(mm)	Total	**Pyr**	Alm	Spe	Gro	Mel	And	Stau	**HCD**	**CrDi**	**LCD**	Amph	Tou	Hm	Rut	FeTi	Ilm	**MgIl**	**Chr**	Spi	Mt	?	*	x	**Total**	KIM	Remarks
93KKA1104	.25-.5	3	**1**						1		**1**															**3**	2	
93KKA1106	.25-.5	1	**1**																							**1**	1	
93KKA1113	.25-.5	1	**1**																							**1**	1	
93KKA1117	.5-1.0	2	**2**																							**2**	2	
93KKA1117	.25-.5	19	**9**								**1**							9								**19**	10	
93KKA1119	.5-1.0	14	**11**											1					**2**							**14**	13	
93KKA1119	.25-.5	94	**88**									**1**						1	**4**						1	**94**	92	
93KKA1122	.25-.5	4	**1**															3								**4**	1	
	Total	474	**228**	51	3	2	1	0	1	**8**	**13**	**33**	2	1	0	1	0	118	**7**	**0**	0	1	3	1	1	**474**	256	
								285				**54**																

APPENDIX 4

ELECTRON MICROPROBE DATA

Note: Total iron is expressed as FeO

Appendix 4

MOUNT	GRAIN	SAMPLE	COLOR	MINERAL	SIZE(mm)	SIO2	TIO2	AL2O3	CR2O3	FEO	MNO	MGO	CAO	NA2O	K2O	TOTAL
T572	45	93KKA1003K	green	Cr-Dioside	0.25-0.5	54.27	0.14	1.95	1.27	2.35	0.14	17.48	19.75	1.60	0.05	98.99
T572	48	93KKA1003K	green	Cr-Dioside	0.25-0.5	54.45	0.20	1.48	1.32	2.38	0.11	16.18	20.14	1.22	0.05	97.53
T572	39	93KKA1003K	purple	Cr-Pyrope	0.25-0.5	40.70	0.33	17.83	7.33	7.13	0.41	19.98	5.73	0.03	0.00	99.47
T572	40	93KKA1003K	purple	Cr-Pyrope	0.25-0.5	40.81	0.47	16.38	8.59	7.02	0.38	19.17	6.58	0.04	0.02	99.47
T572	41	93KKA1003K	purple	Cr-Pyrope	0.25-0.5	40.53	0.74	17.19	7.18	7.57	0.37	17.99	7.77	0.06	0.01	99.39
T572	42	93KKA1003K	purple	Cr-Pyrope	0.25-0.5	40.92	0.09	19.33	5.33	8.54	0.54	19.22	5.15	0.00	0.00	99.11
T572	43	93KKA1003K	rd-ppl	Cr-Pyrope	0.25-0.5	41.58	0.22	20.99	3.24	7.27	0.34	20.80	4.76	0.02	0.01	99.22
T572	44	93KKA1003K	rd-ppl	Cr-Pyrope	0.25-0.5	41.33	0.47	20.12	3.86	7.50	0.31	20.63	5.01	0.04	0.00	99.27
T572	46	93KKA1003K	green	HiCr-Diopside	0.25-0.5	54.58	0.18	1.58	1.93	2.27	0.06	15.77	19.24	1.57	0.06	97.25
T572	47	93KKA1003K	green	HiCr-Diopside	0.25-0.5	55.76	0.24	1.99	2.53	2.53	0.07	16.85	18.76	2.20	0.03	100.96
T572	53	93KKA1003K	black	Ilmenite	0.25-0.5	2.71	48.13	0.09	0.05	44.63	0.50	0.42	0.01	0.01	0.00	96.55
T572	54	93KKA1003K	black	Ilmenite	0.25-0.5	0.13	49.75	0.05	0.02	45.14	1.96	0.01	0.01	0.00	0.00	97.07
T572	55	93KKA1003K	black	Ilmenite	0.25-0.5	0.15	48.94	0.05	0.03	43.70	4.41	0.02	0.02	0.00	0.01	97.32
T572	56	93KKA1003K	black	Ilmenite	0.25-0.5	0.63	47.50	0.04	0.00	47.20	1.76	0.02	0.00	0.01	0.00	97.17
T572	57	93KKA1003K	black	Ilmenite	0.25-0.5	0.04	49.67	0.10	0.03	46.29	0.76	0.39	0.00	0.00	0.00	97.28
T572	51	93KKA1003K	green	LoCr-Diopside	0.25-0.5	51.33	0.03	0.20	0.15	7.45	0.32	13.55	24.37	0.00	0.02	97.42
T572	52	93KKA1003K	green	LoCr-Diopside	0.25-0.5	51.97	0.10	1.29	0.30	6.31	0.32	15.39	22.02	0.33	0.03	98.06
T572	50	93KKA1003K	green	LoCr-Diopside	0.25-0.5	53.65	0.28	2.20	0.36	3.34	0.08	15.90	19.02	1.54	0.03	96.40
T572	49	93KKA1003K	green	LoCr-Diopside	0.25-0.5	53.82	0.27	1.48	0.94	2.76	0.07	16.00	20.15	1.13	0.03	96.64
T628	3	93KKA1003K	dk. green	Cr-Grossular	0.5-1.0	36.44	0.28	12.01	10.92	3.78	4.54	0.34	28.76	0.00	0.00	97.06
T628	1	93KKA1003K	purple	Cr-Pyrope	0.5-1.0	40.21	0.35	17.05	7.83	7.07	0.40	20.03	5.87	0.02	0.00	98.84
T628	2	93KKA1003K	purple	Cr-Pyrope	0.5-1.0	40.93	0.13	20.70	3.14	7.56	0.38	20.80	4.70	0.01	0.00	98.35
T572	58	93KKA1005K	purple	Cr-Pyrope	0.25-0.5	40.97	0.10	16.79	8.94	7.63	0.55	19.11	5.88	0.00	0.03	100.00
T572	59	93KKA1005K	purple	Cr-Pyrope	0.25-0.5	40.82	0.19	16.60	8.78	6.35	0.39	19.40	6.66	0.01	0.02	99.22
T572	60	93KKA1005K	purple	Cr-Pyrope	0.25-0.5	42.07	0.05	19.63	4.96	7.25	0.35	20.31	5.62	0.00	0.00	100.25
T572	61	93KKA1005K	purple	Cr-Pyrope	0.25-0.5	41.17	0.39	18.13	6.58	6.95	0.35	20.52	5.62	0.06	0.00	99.77
T572	62	93KKA1005K	purple	Cr-Pyrope	0.25-0.5	41.20	0.50	18.09	6.39	6.61	0.36	20.85	5.27	0.02	0.01	99.29
T572	63	93KKA1005K	rd-ppl	Cr-Pyrope	0.25-0.5	41.09	0.18	20.47	3.76	8.28	0.41	19.79	4.54	0.00	0.01	98.54
T572	64	93KKA1005K	rd-ppl	Cr-Pyrope	0.25-0.5	40.78	0.68	18.73	4.77	8.48	0.44	17.96	7.45	0.04	0.01	99.33
T572	65	93KKA1005K	purple	Cr-Pyrope	0.25-0.5	41.08	0.33	19.04	5.20	7.64	0.34	20.21	5.13	0.00	0.01	98.97
T572	67	93KKA1005K	green	HiCr-Diopside	0.25-0.5	53.43	0.13	2.28	2.62	1.84	0.07	15.69	19.62	2.41	0.00	98.08
T572	68	93KKA1005K	black	Ilmenite	0.25-0.5	0.20	49.93	0.07	0.09	45.55	0.45	0.55	0.02	0.00	0.01	96.86
T572	69	93KKA1005K	black	Ilmenite	0.25-0.5	0.22	49.62	0.04	0.05	46.83	0.64	0.09	0.00	0.00	0.02	97.51
T572	70	93KKA1005K	black	Ilmenite	0.25-0.5	0.09	51.77	0.03	0.05	45.03	1.16	0.22	0.01	0.01	0.00	98.37
T572	66	93KKA1005K	orange	Spessartine	0.25-0.5	35.26	0.06	19.65	0.00	20.63	20.63	1.14	0.31	0.01	0.00	97.68
T572	71	93KKA1008K	purple	Cr-Pyrope	0.25-0.5	42.78	0.24	17.48	6.55	6.37	0.32	19.44	5.27	0.00	0.00	98.46
T572	72	93KKA1008K	purple	Cr-Pyrope	0.25-0.5	40.73	0.27	18.02	6.75	6.71	0.39	19.96	5.66	0.03	0.01	98.50

MOUNT	GRAIN	SAMPLE	COLOR	MINERAL	SIZE(mm)	SIO2	TIO2	AL2O3	CR2O3	FEO	MNO	MGO	CAO	NA2O	K2O	TOTAL
T572	74	93KKA1008K	black	Ilmenite	0.25-0.5	0.00	49.50	0.06	0.04	46.93	0.53	0.25	0.01	0.04	0.01	97.37
T572	75	93KKA1008K	black	Ilmenite	0.25-0.5	0.00	49.68	0.02	0.03	46.90	0.58	0.15	0.05	0.00	0.01	97.41
T572	76	93KKA1008K	black	Ilmenite	0.25-0.5	0.15	49.84	0.08	0.05	46.39	0.87	0.21	0.03	0.06	0.00	97.67
T572	77	93KKA1008K	black	Ilmenite	0.25-0.5	0.41	48.87	0.06	0.05	46.51	0.65	0.10	0.00	0.00	0.00	96.65
T572	78	93KKA1008K	black	Ilmenite	0.25-0.5	0.00	49.25	0.07	0.02	46.78	0.49	0.45	0.00	0.00	0.00	97.05
T572	73	93KKA1008K	black	Mg-Ilmenite	0.25-0.5	0.82	50.49	0.50	2.74	29.73	0.26	11.94	0.04	0.01	0.00	96.53
T572	79	93KKA1010K	green	Cr-Grossular	0.25-0.5	37.32	0.26	15.18	8.23	0.33	2.78	0.13	33.19	0.01	0.00	97.43
T572	80	93KKA1010K	black	Ilmenite	0.25-0.5	0.00	49.81	0.08	0.06	46.78	0.52	0.39	0.00	0.02	0.00	97.66
T572	88	93KKA1013K	orange	Almandine	0.25-0.5	36.78	0.06	20.94	0.02	28.08	1.01	2.13	9.85	0.01	0.00	98.88
T572	89	93KKA1013K	green	Cr-Dioside	0.25-0.5	53.66	0.18	1.47	1.18	2.98	0.10	17.86	19.47	1.27	0.05	98.24
T572	81	93KKA1013K	purple	Cr-Pyrope	0.25-0.5	40.83	0.02	18.05	7.50	7.70	0.45	20.52	3.97	0.00	0.02	99.06
T572	82	93KKA1013K	purple	Cr-Pyrope	0.25-0.5	40.81	0.21	17.27	7.86	6.33	0.29	20.21	5.83	0.01	0.02	98.83
T572	83	93KKA1013K	purple	Cr-Pyrope	0.25-0.5	40.47	0.08	16.14	9.21	6.65	0.36	20.31	4.99	0.00	0.00	98.20
T572	84	93KKA1013K	purple	Cr-Pyrope	0.25-0.5	40.81	0.00	19.17	5.53	6.95	0.45	20.18	5.23	0.00	0.01	98.33
T572	85	93KKA1013K	purple	Cr-Pyrope	0.25-0.5	41.33	0.15	19.66	4.87	7.89	0.55	19.07	5.72	0.02	0.02	99.28
T572	86	93KKA1013K	purple	Cr-Pyrope	0.25-0.5	41.35	0.33	19.79	4.43	7.00	0.41	20.60	5.01	0.02	0.00	98.96
T572	87	93KKA1013K	purple	Cr-Pyrope	0.25-0.5	41.19	0.44	19.25	4.15	7.32	0.42	19.94	5.05	0.03	0.01	97.79
T572	90	93KKA1013K	black	Ilmenite	0.25-0.5	0.04	50.06	0.04	0.04	45.93	1.37	0.16	0.02	0.00	0.02	97.67
T572	91	93KKA1013K	black	Ilmenite	0.25-0.5	2.01	47.82	0.03	0.10	44.76	1.11	0.34	0.01	0.00	0.01	96.18
T572	92	93KKA1013K	black	Ilmenite	0.25-0.5	0.06	49.82	0.02	0.07	46.81	1.17	0.10	0.00	0.00	0.00	98.05
T572	93	93KKA1013K	black	Ilmenite	0.25-0.5	0.00	49.68	0.05	0.06	46.73	1.16	0.08	0.00	0.02	0.02	97.80
T572	94	93KKA1013K	black	Ilmenite	0.25-0.5	0.02	50.61	0.05	0.00	47.27	0.69	0.07	0.03	0.00	0.00	98.74
T572	95	93KKA1013K	black	Ilmenite	0.25-0.5	0.15	49.94	0.05	0.02	46.34	0.70	0.16	0.00	0.02	0.00	97.38
T572	96	93KKA1013K	black	Ilmenite	0.25-0.5	0.00	50.45	0.06	0.02	46.01	0.85	0.12	0.02	0.00	0.00	97.54
T572	97	93KKA1013K	black	Ilmenite	0.25-0.5	0.30	49.97	0.04	0.03	46.01	0.79	0.20	0.00	0.00	0.02	97.35
T572	98	93KKA1013K	black	Ilmenite	0.25-0.5	0.00	49.26	0.04	0.08	46.35	0.81	0.64	0.01	0.00	0.00	97.19
T572	99	93KKA1013K	black	Ilmenite	0.25-0.5	0.00	50.65	0.08	0.07	46.61	0.76	0.14	0.01	0.00	0.01	98.32
T572	100	93KKA1013K	black	Ilmenite	0.25-0.5	0.00	50.50	0.03	0.05	44.96	2.55	0.03	0.00	0.02	0.00	98.14
T572	101	93KKA1013K	black	Ilmenite	0.25-0.5	0.00	49.73	0.06	0.04	46.61	1.48	0.03	0.02	0.00	0.01	97.98
T572	102	93KKA1013K	black	Ilmenite	0.25-0.5	0.00	50.94	0.03	0.05	45.56	1.72	0.12	0.00	0.00	0.00	98.42
T572	103	93KKA1013K	black	Ilmenite	0.25-0.5	0.20	48.50	0.01	0.07	46.98	1.25	0.20	0.00	0.00	0.00	97.20
T572	104	93KKA1013K	black	Ilmenite	0.25-0.5	0.00	50.12	0.04	0.02	45.67	1.51	0.15	0.00	0.00	0.00	97.52
T572	105	93KKA1013K	black	Ilmenite	0.25-0.5	0.00	49.02	0.06	0.07	46.46	1.64	0.27	0.01	0.00	0.01	97.54
T572	106	93KKA1013K	black	Ilmenite	0.25-0.5	0.27	49.76	0.00	0.05	46.00	0.72	0.11	0.01	0.00	0.00	96.92
T572	107	93KKA1013K	black	Ilmenite	0.25-0.5	0.00	49.57	0.07	0.02	47.27	0.58	0.36	0.06	0.00	0.01	97.92
T572	108	93KKA1013K	black	Ilmenite	0.25-0.5	0.17	49.80	0.04	0.03	46.63	0.99	0.08	0.00	0.00	0.00	97.73
T572	109	93KKA1013K	black	Ilmenite	0.25-0.5	0.00	50.69	0.05	0.20	45.76	0.91	0.53	0.02	0.00	0.02	98.19

MOUNT	GRAIN	SAMPLE	COLOR	MINERAL	SIZE(mm)	SIO2	TIO2	AL2O3	CR2O3	FEO	MNO	MGO	CAO	NA2O	K2O	TOTAL
T572	110	93KKA1013K	black	Ilmenite	0.25-0.5	0.05	49.70	0.03	0.05	46.07	1.37	0.15	0.01	0.00	0.02	97.45
T572	111	93KKA1013K	black	Ilmenite	0.25-0.5	0.00	49.84	0.03	0.01	46.34	1.36	0.20	0.02	0.00	0.02	97.83
T572	112	93KKA1013K	black	Ilmenite	0.25-0.5	0.00	51.13	0.04	0.07	45.35	0.76	0.39	0.01	0.00	0.00	97.75
T572	112	93KKA1013K	black	Ilmenite	0.25-0.5	0.00	51.05	0.06	0.06	45.43	0.87	0.43	0.00	0.00	0.03	97.93
T628	4	93KKA1013K	black	Ilmenite	0.5-1.0	0.08	49.15	0.07	0.10	47.22	1.51	0.04	0.02	0.00	0.00	98.18
T628	5	93KKA1013K	black	Ilmenite	0.5-1.0	0.00	50.19	0.04	0.00	47.18	0.96	0.24	0.02	0.00	0.01	98.64
T573	7	93KKA1016K	rd-ppl	Almandine	0.25-0.5	36.54	0.04	20.86	0.02	37.26	3.91	0.96	0.88	0.02	0.00	100.49
T573	9	93KKA1016K	green	Cr-Diopside	0.25-0.5	54.81	0.29	1.81	1.24	2.72	0.06	17.32	20.46	1.48	0.04	100.24
T573	1	93KKA1016K	purple	Cr-Pyrope	0.25-0.5	41.75	0.00	19.20	6.37	8.58	0.53	18.29	6.68	0.01	0.00	101.39
T573	2	93KKA1016K	purple	Cr-Pyrope	0.25-0.5	41.28	0.39	15.04	10.94	6.46	0.39	19.88	6.28	0.05	0.02	100.74
T573	3	93KKA1016K	purple	Cr-Pyrope	0.25-0.5	42.11	0.65	16.77	8.35	6.61	0.33	20.84	6.21	0.03	0.00	101.90
T573	4	93KKA1016K	purple	Cr-Pyrope	0.25-0.5	42.79	0.34	19.18	5.88	6.97	0.37	21.27	5.54	0.00	0.00	102.34
T573	5	93KKA1016K	rd-ppl	Cr-Pyrope	0.25-0.5	42.54	0.28	20.72	3.85	7.38	0.34	21.55	4.55	0.02	0.01	101.24
T573	6	93KKA1016K	rd-ppl	Cr-Pyrope	0.25-0.5	41.76	0.79	18.18	5.10	8.25	0.30	20.53	5.53	0.02	0.01	100.47
T573	8	93KKA1016K	green	HiCr-Diops.	0.25-0.5	54.52	0.28	1.59	1.56	2.98	0.04	17.43	19.91	1.51	0.05	99.88
T573	11	93KKA1016K	black	Ilmenite	0.25-0.5	0.00	49.10	0.03	0.04	47.40	1.19	0.34	0.02	0.01	0.01	98.14
T573	12	93KKA1016K	black	Ilmenite	0.25-0.5	0.00	49.89	0.07	0.08	47.08	0.47	0.47	0.03	0.00	0.00	98.09
T573	13	93KKA1016K	black	Ilmenite	0.25-0.5	0.00	47.52	0.03	0.06	47.13	2.84	0.15	0.01	0.00	0.00	97.73
T573	10	93KKA1016K	green	LoCr-Diopside	0.25-0.5	54.68	0.26	1.39	0.61	3.89	0.15	19.27	18.55	0.99	0.03	99.83
T628	7	93KKA1016K	green	Cr-Diopside	0.5-1.0	53.24	0.22	1.71	1.32	2.58	0.14	17.00	20.09	1.51	0.03	97.83
T628	6	93KKA1016K	purple	Cr-Pyrope	0.5-1.0	40.12	0.04	18.34	6.40	8.01	0.43	18.67	6.18	0.04	0.00	98.24
T573	14	93KKA1018K	purple	Cr-Pyrope	0.25-0.5	41.32	0.14	17.45	8.04	7.06	0.40	20.19	5.36	0.02	0.00	99.97
T573	15	93KKA1018K	rd-ppl	Cr-Pyrope	0.25-0.5	41.39	0.71	18.24	5.38	8.22	0.32	20.15	5.75	0.01	0.03	100.19
T573	16	93KKA1018K	green	HiCr-Diops.	0.25-0.5	55.35	0.22	1.55	2.55	2.46	0.11	16.42	20.07	1.91	0.02	100.66
T573	17	93KKA1018K	green	HiCr-Diops.	0.25-0.5	58.01	0.13	1.39	1.42	2.44	0.16	15.37	16.42	1.10	0.04	96.48
T573	18	93KKA1018K	black	Ilmenite	0.25-0.5	0.00	49.30	0.11	0.06	47.27	0.43	0.67	0.02	0.02	0.00	97.88
T573	19	93KKA1018K	black	Ilmenite	0.25-0.5	0.00	48.93	0.04	0.09	47.36	1.15	0.43	0.01	0.00	0.00	98.01
T573	20	93KKA1018K	black	Ilmenite	0.25-0.5	0.03	50.00	0.08	0.06	47.30	0.43	0.27	0.02	0.06	0.02	98.25
T573	21	93KKA1019K	purple	Cr-Pyrope	0.25-0.5	42.42	0.15	20.22	5.38	6.88	0.39	20.57	5.88	0.03	0.01	101.94
T573	22	93KKA1019K	purple	Cr-Pyrope	0.25-0.5	42.64	0.00	20.57	4.85	7.00	0.36	21.68	4.28	0.00	0.00	101.39
T573	23	93KKA1019K	green	HiCr-Diops.	0.25-0.5	54.96	0.22	1.58	2.77	2.40	0.11	16.72	19.80	1.98	0.08	100.62
T573	25	93KKA1019K	green	LoCr-Diopside	0.25-0.5	54.18	0.02	1.59	0.77	4.70	0.20	16.36	22.25	0.64	0.01	100.71
T573	24	93KKA1019K	green	LoCr-Diopside	0.25-0.5	55.72	0.12	2.23	0.98	3.04	0.11	18.58	18.03	1.76	0.05	100.60
T573	27	93KKA1023K	orange	Almandine	0.25-0.5	36.75	0.04	20.68	0.06	31.92	7.30	1.57	1.89	0.00	0.00	100.20
T573	28	93KKA1023K	orange	Almandine	0.25-0.5	36.24	0.02	20.41	0.03	32.01	7.29	1.56	1.83	0.09	0.00	99.48
T573	29	93KKA1023K	orange	Almandine	0.25-0.5	37.98	0.13	20.77	0.02	28.00	0.58	2.57	10.53	0.00	0.01	100.58
T573	30	93KKA1023K	orange	Almandine	0.25-0.5	38.37	0.11	21.24	0.03	24.40	1.10	2.27	13.32	0.01	0.03	100.89

Appendix 4

MOUNT	GRAIN	SAMPLE	COLOR	MINERAL	SIZE(mm)	SIO2	TIO2	AL2O3	CR2O3	FEO	MNO	MGO	CAO	NA2O	K2O	TOTAL
T573	31	93KKA1023K	orange	Almandine	0.25-0.5	37.92	0.10	21.38	0.02	28.05	0.79	2.95	9.29	0.00	0.00	100.50
T573	32	93KKA1023K	orange	Almandine	0.25-0.5	37.05	0.08	20.46	0.04	27.55	1.59	2.18	10.14	0.02	0.00	99.12
T573	33	93KKA1023K	green	Cr-Diopside	0.25-0.5	54.95	0.16	1.24	1.07	3.00	0.09	18.86	19.96	0.99	0.07	100.38
T573	26	93KKA1023K	purple	Cr-Pyrope	0.25-0.5	41.27	0.34	16.34	8.71	7.35	0.32	19.49	6.80	0.01	0.00	100.62
T573	35	93KKA1023K	black	Ilmenite	0.25-0.5	0.00	49.44	0.10	0.04	46.76	0.58	0.60	0.00	0.01	0.00	97.52
T573	36	93KKA1023K	black	Ilmenite	0.25-0.5	0.00	50.60	0.06	0.02	46.63	0.56	0.16	0.00	0.00	0.00	98.03
T573	37	93KKA1023K	black	Ilmenite	0.25-0.5	0.00	46.02	0.06	0.08	50.13	0.39	0.50	0.00	0.02	0.01	97.21
T573	38	93KKA1023K	black	Ilmenite	0.25-0.5	0.00	49.79	0.05	0.06	45.21	2.63	0.18	0.00	0.00	0.01	97.92
T573	39	93KKA1023K	black	Ilmenite	0.25-0.5	0.00	50.79	0.06	0.07	45.52	2.15	0.08	0.01	0.00	0.01	98.68
T573	40	93KKA1023K	black	Ilmenite	0.25-0.5	0.00	47.57	0.04	0.05	45.82	3.47	0.45	0.00	0.00	0.01	97.40
T573	41	93KKA1023K	black	Ilmenite	0.25-0.5	0.00	49.65	0.08	0.06	47.83	0.49	0.40	0.01	0.00	0.02	98.53
T573	42	93KKA1023K	black	Ilmenite	0.25-0.5	0.00	49.30	0.04	0.04	47.46	0.67	0.17	0.04	0.02	0.00	97.74
T573	34	93KKA1023K	green	LoCr-Diopside	0.25-0.5	53.09	0.09	1.06	0.38	5.38	0.22	16.07	22.35	0.60	0.02	99.24
T573	48	93KKA1026K	orange	Almandine	0.25-0.5	37.96	0.16	21.06	0.02	26.23	2.09	2.72	10.12	0.00	0.00	100.37
T573	50	93KKA1026K	orange	Almandine	0.25-0.5	38.05	0.08	21.24	0.02	23.56	1.02	1.85	14.56	0.00	0.00	100.38
T573	52	93KKA1026K	orange	Almandine	0.25-0.5	37.67	0.07	21.24	0.06	25.28	2.11	2.09	11.75	0.02	0.00	100.30
T573	43	93KKA1026K	purple	Cr-Pyrope	0.25-0.5	41.62	0.36	15.78	10.33	6.48	0.35	20.12	6.46	0.00	0.02	101.52
T573	44	93KKA1026K	purple	Cr-Pyrope	0.25-0.5	42.53	0.23	20.03	4.96	6.70	0.36	21.76	4.95	0.03	0.00	101.53
T573	45	93KKA1026K	purple	Cr-Pyrope	0.25-0.5	42.34	0.31	18.82	6.24	6.91	0.37	20.85	5.47	0.00	0.00	101.32
T573	46	93KKA1026K	rd-ppl	Cr-Pyrope	0.25-0.5	40.54	0.21	17.48	6.62	12.47	0.74	15.91	6.97	0.00	0.01	100.95
T573	47	93KKA1026K	purple	Cr-Pyrope	0.25-0.5	38.52	0.03	16.21	9.20	8.30	0.49	17.81	5.00	0.00	0.04	95.61
T573	55	93KKA1026K	black	Ilmenite	0.25-0.5	0.00	49.80	0.04	0.04	47.30	0.53	0.23	0.00	0.00	0.00	97.94
T573	56	93KKA1026K	black	Ilmenite	0.25-0.5	0.00	49.45	0.03	0.05	47.48	0.57	0.18	0.03	0.00	0.01	97.79
T573	57	93KKA1026K	black	Ilmenite	0.25-0.5	0.00	49.82	0.06	0.07	47.94	0.54	0.44	0.03	0.00	0.00	98.89
T573	58	93KKA1026K	black	Ilmenite	0.25-0.5	0.00	49.05	0.06	0.01	47.77	0.73	0.17	0.02	0.00	0.00	97.80
T573	59	93KKA1026K	black	Ilmenite	0.25-0.5	0.00	49.78	0.06	0.08	47.44	0.60	0.24	0.03	0.00	0.02	98.25
T573	54	93KKA1026K	green	LoCr-Diopside	0.25-0.5	53.49	0.02	1.03	0.21	4.70	0.24	16.91	22.33	0.37	0.00	99.30
T573	53	93KKA1026K	green	LoCr-Diopside	0.25-0.5	53.60	0.18	1.38	0.97	2.72	0.09	17.57	21.15	1.03	0.03	98.70
T573	49	93KKA1026K	orange	Spessartine	0.25-0.5	35.67	0.07	19.96	0.03	15.69	27.43	0.28	0.36	0.00	0.00	99.49
T573	51	93KKA1026K	orange	Spessartine	0.25-0.5	35.64	0.13	19.73	0.00	15.29	27.34	0.33	0.19	0.05	0.00	98.69
T628	8	93KKA1026K	purple	Cr-Pyrope	0.5-1.0	39.43	0.42	15.34	9.97	6.89	0.38	18.49	7.07	0.02	0.00	98.00
T573	63	93KKA1028K	orange	Almandine	0.25-0.5	39.33	0.11	22.13	0.05	22.49	0.78	8.33	7.85	0.00	0.00	101.07
T573	64	93KKA1028K	orange	Almandine	0.25-0.5	38.07	0.08	21.39	0.05	24.24	2.20	2.22	12.58	0.00	0.00	100.83
T573	60	93KKA1028K	purple	Cr-Pyrope	0.25-0.5	40.70	0.31	15.12	10.98	7.00	0.42	19.19	7.16	0.06	0.00	100.95
T573	61	93KKA1028K	purple	Cr-Pyrope	0.25-0.5	42.44	0.42	19.23	5.09	7.61	0.35	21.22	5.39	0.00	0.01	101.76
T573	62	93KKA1028K	rd-ppl	Cr-Pyrope	0.25-0.5	42.45	0.85	19.15	4.30	8.34	0.32	20.72	5.62	0.02	0.00	101.77
T573	67	93KKA1028K	black	Ilmenite	0.25-0.5	0.00	49.40	0.07	0.04	46.38	1.74	0.01	0.02	0.00	0.00	97.66

MOUNT	GRAIN	SAMPLE	COLOR	MINERAL	SIZE(mm)	SIO2	TIO2	AL2O3	CR2O3	FEO	MNO	MGO	CAO	NA2O	K2O	TOTAL
T573	68	93KKA1028K	black	Ilmenite	0.25-0.5	0.00	49.63	0.09	0.05	46.66	1.09	0.27	0.02	0.00	0.00	97.82
T573	69	93KKA1028K	black	Ilmenite	0.25-0.5	0.00	48.39	0.11	0.04	48.22	0.47	0.39	0.00	0.00	0.00	97.62
T573	70	93KKA1028K	black	Ilmenite	0.25-0.5	0.00	46.50	0.04	0.05	48.32	1.62	0.92	0.02	0.00	0.01	97.49
T573	72	93KKA1028K	black	Ilmenite	0.25-0.5	0.00	48.53	0.09	0.08	47.02	0.90	1.15	0.01	0.00	0.00	97.78
T573	73	93KKA1028K	black	Ilmenite	0.25-0.5	0.00	47.66	0.05	0.00	47.74	1.66	1.13	0.00	0.00	0.00	98.23
T573	66	93KKA1028K	green	LoCr-Diopside	0.25-0.5	54.29	0.03	0.87	0.47	4.62	0.20	16.82	22.69	0.39	0.00	100.38
T573	65	93KKA1028K	green	LoCr-Diopside	0.25-0.5	53.29	0.09	1.63	0.53	4.34	0.13	16.62	22.68	0.33	0.02	99.64
T573	71	93KKA1028K	black	Ti-Magnetite	0.25-0.5	0.06	14.73	0.26	0.43	76.01	0.11	0.26	0.00	0.02	0.00	91.88
T573	74	93KKA1031K	orange	Almandine	0.25-0.5	35.97	0.07	20.25	0.00	31.69	6.73	2.58	2.08	0.04	0.02	99.42
T573	75	93KKA1031K	orange	Almandine	0.25-0.5	36.83	0.03	20.60	0.02	35.35	4.39	2.18	1.06	0.00	0.00	100.46
T573	76	93KKA1031K	orange	Almandine	0.25-0.5	37.43	0.17	20.79	0.02	24.84	2.86	1.87	11.71	0.00	0.01	99.70
T573	77	93KKA1031K	orange	Almandine	0.25-0.5	37.28	0.03	20.69	0.03	31.08	3.87	1.99	5.32	0.00	0.00	100.30
T573	78	93KKA1031K	orange	Almandine	0.25-0.5	38.20	0.10	21.55	0.06	28.23	0.75	2.74	9.35	0.00	0.00	100.98
T573	79	93KKA1031K	orange	Almandine	0.25-0.5	38.19	0.10	21.22	0.02	26.53	0.95	2.73	11.34	0.00	0.00	101.08
T573	81	93KKA1034K	black	Ilmenite	0.25-0.5	0.00	49.08	0.12	0.09	47.58	0.58	0.29	0.00	0.00	0.02	97.76
T573	80	93KKA1034K	black	Rutile	0.25-0.5	0.00	92.18	0.05	0.23	4.55	0.07	0.08	0.00	0.00	0.03	97.18
T573	84	93KKA1038K	orange	Almandine	0.25-0.5	38.03	0.07	21.33	0.01	28.07	1.12	2.64	9.42	0.01	0.02	100.71
T573	85	93KKA1038K	orange	Almandine	0.25-0.5	36.75	0.08	20.93	0.02	30.66	2.01	1.15	8.43	0.00	0.00	100.02
T573	82	93KKA1038K	purple	Cr-Pyrope	0.25-0.5	41.77	0.36	19.28	5.37	6.72	0.33	21.20	5.36	0.04	0.00	100.44
T573	83	93KKA1038K	purple	Cr-Pyrope	0.25-0.5	41.74	0.31	18.95	5.73	7.68	0.34	20.57	5.77	0.03	0.01	101.11
T573	86	93KKA1038K	black	Ilmenite	0.25-0.5	0.00	46.09	0.06	0.06	50.10	0.72	0.11	0.00	0.02	0.00	97.17
T573	87	93KKA1038K	black	Melanite	0.25-0.5	34.76	3.78	4.12	0.06	20.84	0.53	0.37	32.54	0.16	0.02	97.18
T573	103	93KKA1044K	green	?	0.25-0.5	46.53	0.02	0.16	0.04	10.20	0.70	4.07	18.54	0.10	0.00	80.35
T573	92	93KKA1044K	orange	Almandine	0.25-0.5	37.66	0.08	21.44	0.02	27.07	1.04	2.82	10.52	0.00	0.00	100.65
T573	93	93KKA1044K	orange	Almandine	0.25-0.5	37.60	0.07	21.14	0.03	27.58	1.27	2.95	9.16	0.00	0.02	99.81
T573	94	93KKA1044K	orange	Almandine	0.25-0.5	37.06	0.18	20.81	0.11	21.32	10.04	2.44	8.23	0.02	0.00	100.21
T573	95	93KKA1044K	orange	Almandine	0.25-0.5	37.41	0.16	20.90	0.04	27.83	2.42	1.70	9.89	0.00	0.03	100.36
T573	96	93KKA1044K	orange	Almandine	0.25-0.5	37.47	0.04	21.35	0.06	24.16	2.83	1.65	12.44	0.04	0.03	100.07
T573	97	93KKA1044K	orange	Almandine	0.25-0.5	37.39	0.05	20.75	0.00	27.01	1.54	1.64	11.52	0.00	0.00	99.90
T573	98	93KKA1044K	green	Cr-Diopside	0.25-0.5	54.55	0.16	1.73	1.21	2.41	0.09	17.42	20.92	1.37	0.04	99.90
T573	88	93KKA1044K	purple	Cr-Pyrope	0.25-0.5	41.03	0.22	18.40	6.30	8.46	0.50	18.64	6.49	0.02	0.02	100.07
T573	89	93KKA1044K	purple	Cr-Pyrope	0.25-0.5	40.80	0.11	18.95	5.75	12.40	0.57	17.40	4.75	0.00	0.00	100.72
T573	90	93KKA1044K	purple	Cr-Pyrope	0.25-0.5	41.74	0.24	20.03	4.46	7.72	0.46	20.94	4.64	0.01	0.02	100.25
T573	91	93KKA1044K	purple	Cr-Pyrope	0.25-0.5	41.12	0.46	19.41	4.35	8.31	0.35	19.40	6.54	0.04	0.00	99.97
T573	104	93KKA1044K	green	Hedenbergite	0.25-0.5	50.22	0.06	0.39	0.11	19.80	0.66	5.61	23.19	0.16	0.00	100.19
T573	99	93KKA1044K	green	LoCr-Diopside	0.25-0.5	52.54	0.05	0.29	0.10	11.70	0.57	11.30	24.07	0.10	0.03	100.76
T573	102	93KKA1044K	green	LoCr-Diopside	0.25-0.5	53.19	0.02	0.93	0.14	6.43	0.30	15.62	22.98	0.52	0.01	100.14

MOUNT	GRAIN	SAMPLE	COLOR	MINERAL	SIZE(mm)	SIO2	TIO2	AL2O3	CR2O3	FEO	MNO	MGO	CAO	NA2O	K2O	TOTAL
T573	100	93KKA1044K	green	LoCr-Diopside	0.25-0.5	52.11	0.07	0.23	0.21	10.98	0.32	11.76	24.13	0.06	0.00	99.87
T573	101	93KKA1044K	green	LoCr-Diopside	0.25-0.5	54.10	0.02	1.01	0.41	9.50	0.38	14.23	20.90	0.25	0.02	100.81
T573	105	93KKA1044K	green	LoCr-Diopside	0.25-0.5	53.62	0.15	1.30	0.59	4.04	0.11	18.11	22.45	0.18	0.02	100.55
T573	109	93KKA1046K	orange	Almandine	0.25-0.5	38.11	0.08	20.93	0.07	25.35	1.09	2.38	12.30	0.00	0.01	100.32
T573	110	93KKA1046K	orange	Almandine	0.25-0.5	37.67	0.03	21.13	0.06	30.17	0.67	3.20	7.56	0.02	0.00	100.53
T573	111	93KKA1046K	orange	Almandine	0.25-0.5	38.05	0.07	21.19	0.04	28.29	1.68	2.02	9.96	0.00	0.01	101.29
T573	112	93KKA1046K	orange	Almandine	0.25-0.5	37.99	0.02	21.31	0.04	29.84	0.94	5.14	5.47	0.00	0.00	100.75
T573	113	93KKA1046K	orange	Almandine	0.25-0.5	38.02	0.05	21.24	0.05	23.75	2.04	1.77	13.61	0.00	0.01	100.54
T573	106	93KKA1046K	purple	Cr-Pyrope	0.25-0.5	41.62	0.05	17.24	9.38	6.87	0.48	23.74	1.17	0.01	0.01	100.55
T573	107	93KKA1046K	purple	Cr-Pyrope	0.25-0.5	41.85	0.10	18.20	7.49	6.30	0.38	21.91	4.20	0.03	0.00	100.47
T573	108	93KKA1046K	purple	Cr-Pyrope	0.25-0.5	42.13	0.27	20.22	4.19	6.93	0.36	21.48	4.68	0.05	0.00	100.30
T573	114	93KKA1046K	green	LoCr-Diopside	0.25-0.5	52.56	0.04	0.94	0.27	7.03	0.29	13.87	24.66	0.22	0.00	99.89
T574	3	93KKA1049K	orange	Almandine	0.25-0.5	38.22	0.08	21.28	0.01	24.57	1.15	2.47	12.99	0.00	0.00	100.77
T574	4	93KKA1049K	orange	Almandine	0.25-0.5	38.45	0.18	21.16	0.06	20.42	3.51	2.43	14.30	0.00	0.00	100.51
T574	5	93KKA1049K	orange	Almandine	0.25-0.5	38.51	0.12	21.59	0.02	25.63	1.11	2.42	11.75	0.05	0.01	101.21
T574	6	93KKA1049K	green	Cr-Diopside	0.25-0.5	55.44	0.21	1.67	1.04	2.82	0.11	18.33	19.69	1.37	0.06	100.74
T574	1	93KKA1049K	purple	Cr-Pyrope	0.25-0.5	42.11	0.25	19.07	6.10	6.82	0.30	21.46	5.09	0.00	0.01	101.21
T574	2	93KKA1049K	rd-ppl	Cr-Pyrope	0.25-0.5	42.11	0.79	18.85	5.25	8.77	0.41	20.06	5.99	0.05	0.01	102.28
T574	7	93KKA1049K	black	Ilmenite	0.25-0.5	0.00	49.16	0.10	0.14	47.78	0.49	0.41	0.03	0.00	0.01	98.13
T574	8	93KKA1049K	black	Ilmenite	0.25-0.5	0.00	49.24	0.07	0.09	47.66	0.61	0.22	0.00	0.03	0.01	97.93
T574	10	93KKA1050K	orange	Almandine	0.25-0.5	38.15	0.06	21.31	0.03	28.47	0.94	4.61	6.88	0.00	0.00	100.45
T574	11	93KKA1050K	orange	Almandine	0.25-0.5	37.44	0.04	20.75	0.05	26.70	1.52	2.44	10.88	0.01	0.02	99.85
T574	12	93KKA1050K	orange	Almandine	0.25-0.5	37.19	0.03	21.04	0.02	29.36	1.22	2.99	7.55	0.00	0.00	99.41
T574	13	93KKA1050K	orange	Almandine	0.25-0.5	38.23	0.04	21.23	0.06	24.89	1.38	2.54	12.16	0.00	0.01	100.54
T574	14	93KKA1050K	orange	Almandine	0.25-0.5	37.22	0.03	20.75	0.00	27.93	1.92	1.85	9.88	0.00	0.02	99.60
T574	9	93KKA1050K	purple	Cr-Pyrope	0.25-0.5	41.92	0.21	18.21	7.09	7.20	0.39	20.22	5.95	0.02	0.01	101.22
T574	17	93KKA1050K	black	Ilmenite	0.25-0.5	0.00	48.75	0.10	0.05	47.46	0.50	0.47	0.02	0.00	0.00	97.36
T574	18	93KKA1050K	black	Ilmenite	0.25-0.5	0.87	50.34	0.66	0.06	43.89	1.55	1.01	0.02	0.00	0.01	98.41
T574	19	93KKA1050K	black	Ilmenite	0.25-0.5	0.04	47.92	0.04	0.09	49.53	2.02	0.06	0.01	0.02	0.00	99.71
T574	20	93KKA1050K	black	Ilmenite	0.25-0.5	0.00	49.78	0.00	0.04	45.61	2.07	0.10	0.04	0.01	0.01	97.65
T574	15	93KKA1050K	green	LoCr-Diopside	0.25-0.5	54.05	0.07	0.59	0.10	5.58	0.19	15.26	23.82	0.63	0.00	100.27
T574	16	93KKA1050K	green	LoCr-Diopside	0.25-0.5	53.05	0.10	1.36	0.22	4.96	0.19	16.24	21.84	0.45	0.01	98.41
T574	21	93KKA1054K	orange	Almandine	0.25-0.5	36.88	0.02	20.68	0.01	28.13	12.87	1.24	0.67	0.00	0.00	100.49
T574	22	93KKA1054K	yl-ong	Almandine	0.25-0.5	37.01	0.10	20.32	0.00	17.81	22.70	0.96	1.05	0.00	0.00	99.94
T574	24	93KKA1054K	black	Amphibole	0.25-0.5	44.59	0.41	13.23	0.04	16.72	0.30	9.41	11.47	1.09	0.31	97.55
T574	23	93KKA1054K	black	Ilmenite	0.25-0.5	0.00	49.75	0.07	0.07	46.11	0.40	0.92	0.00	0.00	0.00	97.31
T574	25	93KKA1057K	purple	Cr-Pyrope	0.25-0.5	42.18	0.27	19.56	5.29	7.26	0.37	21.10	4.88	0.02	0.02	100.94

MOUNT	GRAIN	SAMPLE	COLOR	MINERAL	SIZE(mm)	SIO2	TIO2	AL2O3	CR2O3	FEO	MNO	MGO	CAO	NA2O	K2O	TOTAL
T574	27	93KKA1057K	black	Ilmenite	0.25-0.5	0.00	50.47	0.03	0.08	45.24	1.76	0.11	0.00	0.00	0.02	97.71
T574	28	93KKA1057K	black	Ilmenite	0.25-0.5	0.00	50.61	0.06	0.06	45.49	1.70	0.13	0.02	0.02	0.00	98.08
T574	29	93KKA1057K	black	Ilmenite	0.25-0.5	0.00	50.36	0.06	0.07	46.14	1.67	0.19	0.01	0.00	0.00	98.50
T574	26	93KKA1057K	green	LoCr-Diopside	0.25-0.5	54.49	0.03	0.36	0.06	3.30	0.13	17.17	25.04	0.18	0.01	100.77
T574	35	93KKA1063K	orange	Almandine	0.25-0.5	37.27	0.05	20.64	0.03	28.52	12.62	1.14	1.02	0.00	0.01	101.29
T574	36	93KKA1063K	orange	Almandine	0.25-0.5	37.53	0.07	20.97	0.05	23.89	3.43	1.80	11.99	0.00	0.01	99.74
T574	37	93KKA1063K	green	Cr-Diopside	0.25-0.5	54.98	0.24	1.58	1.22	2.61	0.10	17.70	20.63	1.36	0.07	100.50
T574	30	93KKA1063K	purple	Cr-Pyrope	0.25-0.5	41.20	0.13	17.50	8.03	6.40	0.33	21.22	4.99	0.01	0.00	99.79
T574	31	93KKA1063K	purple	Cr-Pyrope	0.25-0.5	41.85	0.26	18.36	6.71	6.42	0.35	21.18	5.54	0.03	0.00	100.68
T574	32	93KKA1063K	purple	Cr-Pyrope	0.25-0.5	41.87	0.29	18.99	6.11	7.28	0.41	20.78	4.99	0.02	0.01	100.73
T574	33	93KKA1063K	purple	Cr-Pyrope	0.25-0.5	41.13	0.31	18.45	6.64	6.69	0.41	20.64	5.16	0.03	0.02	99.49
T574	34	93KKA1063K	purple	Cr-Pyrope	0.25-0.5	41.73	0.33	18.64	6.06	6.88	0.36	21.10	5.39	0.02	0.01	100.52
T574	40	93KKA1063K	black	Ilmenite	0.25-0.5	0.00	48.97	0.05	0.05	47.18	1.56	0.13	0.03	0.00	0.00	97.97
T574	41	93KKA1063K	black	Ilmenite	0.25-0.5	0.00	49.03	0.09	0.05	46.73	0.44	0.65	0.01	0.01	0.00	97.00
T574	42	93KKA1063K	black	Ilmenite	0.25-0.5	0.00	48.97	0.06	0.02	46.80	1.33	0.19	0.03	0.00	0.00	97.39
T574	43	93KKA1063K	black	Ilmenite	0.25-0.5	0.00	51.02	0.05	0.06	46.49	0.14	0.16	0.04	0.00	0.00	97.95
T574	44	93KKA1063K	black	Ilmenite	0.25-0.5	0.00	46.71	0.03	0.06	48.72	1.12	1.31	0.00	0.00	0.00	97.95
T574	39	93KKA1063K	green	LoCr-Diopside	0.25-0.5	53.37	0.06	1.15	0.53	5.34	0.57	14.80	24.33	0.16	0.00	100.32
T574	38	93KKA1063K	green	LoCr-Diopside	0.25-0.5	54.78	0.25	1.68	0.95	3.32	0.12	17.89	20.13	1.30	0.04	100.44
T574	45	93KKA1064K	rd-ppl	Cr-Pyrope	0.25-0.5	41.68	0.39	19.47	4.69	7.56	0.33	20.77	5.29	0.00	0.01	100.18
T574	50	93KKA1066K	orange	Almandine	0.25-0.5	36.59	0.10	20.68	0.03	28.18	0.89	1.76	10.28	0.00	0.03	98.53
T574	51	93KKA1066K	orange	Almandine	0.25-0.5	36.52	0.02	20.59	0.04	31.77	7.09	2.52	0.91	0.02	0.00	99.49
T574	52	93KKA1066K	orange	Almandine	0.25-0.5	37.42	0.10	20.79	0.03	29.11	0.37	2.52	9.44	0.00	0.00	99.78
T574	56	93KKA1066K	dk.gy	Amphibole	0.25-0.5	43.47	1.41	10.41	0.02	19.87	0.30	8.84	11.24	1.21	0.98	97.74
T574	53	93KKA1066K	green	Cr-Diopside	0.25-0.5	54.94	0.24	1.72	1.19	2.89	0.06	17.93	19.38	1.48	0.06	99.88
T574	46	93KKA1066K	purple	Cr-Pyrope	0.25-0.5	40.91	0.31	15.53	10.53	6.54	0.35	20.53	5.39	0.00	0.01	100.09
T574	47	93KKA1066K	purple	Cr-Pyrope	0.25-0.5	41.09	0.30	16.17	8.77	7.50	0.35	19.07	6.29	0.00	0.00	99.53
T574	49	93KKA1066K	purple	Cr-Pyrope	0.25-0.5	41.25	0.45	19.27	4.88	7.16	0.29	20.71	5.29	0.04	0.00	99.34
T574	54	93KKA1066K	black	Ilmenite	0.25-0.5	0.00	49.00	0.10	0.06	46.94	0.47	0.28	0.00	0.01	0.01	96.86
T574	55	93KKA1066K	black	Ilmenite	0.25-0.5	0.00	49.15	0.04	0.03	44.85	3.18	0.03	0.00	0.00	0.00	97.29
T574	48	93KKA1066K		plucked	0.25-0.5	1.87	0.02	0.00	0.02	0.00	0.03	0.02	0.00	0.09	0.00	2.05
T574	57	93KKA1069K	purple	Cr-Pyrope	0.25-0.5	41.50	0.07	18.33	7.39	7.13	0.41	19.49	6.24	0.02	0.01	100.59
T574	58	93KKA1069K	purple	Cr-Pyrope	0.25-0.5	41.97	0.02	19.17	6.45	8.29	0.55	20.84	4.08	0.02	0.00	101.38
T574	59	93KKA1069K	purple	Cr-Pyrope	0.25-0.5	42.16	0.24	18.02	6.88	6.50	0.29	21.08	5.92	0.00	0.00	101.10
T574	60	93KKA1069K	green	LoCr-Diopside	0.25-0.5	53.72	0.27	1.55	0.85	2.96	0.08	17.09	20.46	1.33	0.05	98.36
T574	66	93KKA1071K	green	Cr-Diopside	0.25-0.5	54.73	0.14	1.86	1.09	2.73	0.05	17.78	19.89	1.46	0.05	99.78
T574	61	93KKA1071K	purple	Cr-Pyrope	0.25-0.5	41.48	0.09	16.92	9.05	7.70	0.46	17.84	7.11	0.01	0.00	100.67

MOUNT	GRAIN	SAMPLE	COLOR	MINERAL	SIZE(mm)	SIO2	TIO2	AL2O3	CR2O3	FEO	MNO	MGO	CAO	NA2O	K2O	TOTAL
T574	62	93KKA1071K	purple	Cr-Pyrope	0.25-0.5	40.92	0.23	15.86	10.05	6.24	0.39	20.63	5.79	0.02	0.01	100.14
T574	63	93KKA1071K	purple	Cr-Pyrope	0.25-0.5	40.68	0.00	17.84	7.91	7.46	0.40	21.55	3.50	0.00	0.01	99.35
T574	64	93KKA1071K	purple	Cr-Pyrope	0.25-0.5	42.09	0.24	19.18	5.82	6.90	0.32	20.94	5.42	0.01	0.03	100.94
T574	65	93KKA1071K	rd-ppl	Cr-Pyrope	0.25-0.5	42.15	0.16	20.75	3.70	7.18	0.32	21.15	4.90	0.03	0.01	100.34
T574	71	93KKA1072K	orange	Almandine	0.25-0.5	37.41	0.01	21.12	0.08	32.69	1.70	5.68	1.01	0.05	0.00	99.74
T574	67	93KKA1072K	purple	Cr-Pyrope	0.25-0.5	41.19	0.14	16.79	8.50	6.68	0.35	20.07	5.88	0.00	0.00	99.60
T574	68	93KKA1072K	purple	Cr-Pyrope	0.25-0.5	41.64	0.30	19.61	4.72	7.32	0.36	20.70	5.21	0.02	0.00	99.88
T574	69	93KKA1072K	purple	Cr-Pyrope	0.25-0.5	41.65	0.40	19.46	4.84	7.04	0.34	20.92	4.78	0.06	0.01	99.48
T574	70	93KKA1072K	purple	Cr-Pyrope	0.25-0.5	41.44	0.60	18.88	5.00	7.82	0.34	20.52	5.22	0.01	0.01	99.84
T574	72	93KKA1075K	purple	Cr-Pyrope	0.25-0.5	41.38	0.04	17.55	8.42	8.94	0.60	18.42	5.61	0.01	0.00	100.96
T574	73	93KKA1075K	purple	Cr-Pyrope	0.25-0.5	41.68	0.01	18.25	7.66	7.92	0.53	18.74	6.59	0.00	0.00	101.36
T574	74	93KKA1075K	purple	Cr-Pyrope	0.25-0.5	41.77	0.35	18.23	6.60	7.68	0.38	20.13	5.65	0.01	0.02	100.82
T574	75	93KKA1075K	purple	Cr-Pyrope	0.25-0.5	41.73	0.36	18.08	7.02	6.92	0.41	20.53	5.39	0.06	0.02	100.50
T574	76	93KKA1075K	purple	Cr-Pyrope	0.25-0.5	41.60	0.56	18.88	5.25	8.18	0.39	19.32	6.48	0.01	0.01	100.68
T574	77	93KKA1075K	green	HiCr-Diops.	0.25-0.5	54.13	0.18	2.05	1.84	2.53	0.10	16.78	19.18	2.05	0.12	98.96
T574	78	93KKA1075K	black	Ilmenite	0.25-0.5	0.00	49.64	0.06	0.04	45.66	1.63	0.10	0.01	0.00	0.00	97.15
T574	79	93KKA1075K	black	Ilmenite	0.25-0.5	0.00	49.77	0.06	0.02	44.78	3.56	0.02	0.01	0.01	0.00	98.21
T574	80	93KKA1075K	black	Ilmenite	0.25-0.5	0.00	48.87	0.02	0.01	44.61	3.28	0.16	0.02	0.00	0.01	96.98
T574	81	93KKA1075K	black	Ilmenite	0.25-0.5	0.00	51.38	0.04	0.09	45.29	1.57	0.34	0.00	0.00	0.00	98.70
T574	82	93KKA1075K	black	Ilmenite	0.25-0.5	0.00	49.92	0.04	0.00	46.30	1.05	0.41	0.01	0.00	0.00	97.73
T574	83	93KKA1075K	black	Ilmenite	0.25-0.5	0.00	49.82	0.06	0.08	45.75	2.36	0.15	0.01	0.00	0.00	98.22
T574	84	93KKA1075K	black	Ilmenite	0.25-0.5	0.00	48.88	0.08	0.04	47.49	0.69	0.82	0.00	0.00	0.01	98.00
T574	87	93KKA1078K	orange	Almandine	0.25-0.5	36.62	0.04	20.81	0.08	31.87	2.74	5.15	1.06	0.01	0.01	98.38
T574	85	93KKA1078K	purple	Cr-Pyrope	0.25-0.5	40.60	0.25	17.23	7.62	7.23	0.39	19.81	5.65	0.03	0.00	98.82
T574	86	93KKA1078K	purple	Cr-Pyrope	0.25-0.5	40.79	0.30	18.16	6.43	6.61	0.30	20.29	5.53	0.04	0.00	98.44
T574	88	93KKA1078K	black	Ilmenite	0.25-0.5	0.00	49.17	0.02	0.13	46.57	0.55	0.50	0.00	0.00	0.01	96.94
T574	89	93KKA1078K	black	Ilmenite	0.25-0.5	0.00	49.90	0.10	0.04	44.89	1.56	0.63	0.04	0.00	0.00	97.15
T574	90	93KKA1078K	black	Ilmenite	0.25-0.5	0.00	48.95	0.06	0.02	43.65	4.99	0.01	0.03	0.03	0.01	97.74
T574	91	93KKA1078K	black	Ilmenite	0.25-0.5	0.00	49.20	0.02	0.04	46.62	1.17	0.30	0.02	0.00	0.00	97.36
T574	92	93KKA1078K	black	Ilmenite	0.25-0.5	0.00	51.19	0.02	0.10	45.46	0.87	0.38	0.03	0.03	0.02	98.09
T574	93	93KKA1080K	purple	Cr-Pyrope	0.25-0.5	41.01	0.01	16.12	10.28	7.84	0.57	17.67	7.85	0.01	0.01	101.36
T574	94	93KKA1080K	purple	Cr-Pyrope	0.25-0.5	41.63	0.41	16.89	8.76	7.46	0.46	19.65	6.04	0.04	0.00	101.34
T574	95	93KKA1080K	purple	Cr-Pyrope	0.25-0.5	41.37	0.16	17.58	7.59	6.72	0.42	20.97	5.01	0.00	0.00	99.83
T574	96	93KKA1080K	purple	Cr-Pyrope	0.25-0.5	41.32	0.63	16.19	9.02	6.62	0.40	20.73	5.21	0.00	0.00	100.12
T574	97	93KKA1080K	purple	Cr-Pyrope	0.25-0.5	40.57	0.58	17.64	6.89	7.80	0.37	19.60	6.18	0.03	0.02	99.68
T574	98	93KKA1080K	purple	Cr-Pyrope	0.25-0.5	41.79	0.26	20.42	3.70	7.74	0.33	20.96	4.53	0.01	0.01	99.76
T574	99	93KKA1080K	purple	Cr-Pyrope	0.25-0.5	41.27	0.48	19.21	4.72	7.86	0.30	20.36	5.24	0.00	0.02	99.45

Appendix 4

MOUNT	GRAIN	SAMPLE	COLOR	MINERAL	SIZE(mm)	SIO2	TIO2	AL2O3	CR2O3	FEO	MNO	MGO	CAO	NA2O	K2O	TOTAL
T574	100	93KKA1080K	rd-ppl	Cr-Pyrope	0.25-0.5	41.34	0.62	19.32	4.65	7.77	0.40	19.75	5.75	0.04	0.01	99.65
T574	101	93KKA1080K	green	LoCr-Diopside	0.25-0.5	51.45	0.11	3.01	0.53	5.08	0.18	15.02	22.53	0.53	0.00	98.44
T575	3	93KKA1083K	black	Ilmenite	0.25-0.5	0.00	49.48	0.04	0.05	47.42	1.38	0.24	0.00	0.00	0.01	98.61
T575	4	93KKA1083K	black	Ilmenite	0.25-0.5	0.02	48.56	0.01	0.05	48.24	1.54	0.19	0.00	0.00	0.00	98.60
T575	5	93KKA1083K	black	Ilmenite	0.25-0.5	0.05	47.94	0.04	0.05	48.46	1.49	0.24	0.00	0.04	0.00	98.31
T575	6	93KKA1083K	black	Ilmenite	0.25-0.5	0.00	48.07	0.06	0.03	47.75	1.47	0.22	0.02	0.00	0.00	97.62
T575	2	93KKA1083K	green	LoCr-Diopside	0.25-0.5	55.13	0.21	1.56	0.64	3.17	0.12	17.30	21.35	1.31	0.03	100.82
T575	1	93KKA1083K	green	LoCr-Diopside	0.25-0.5	55.37	0.21	1.65	0.67	3.98	0.08	20.32	17.13	1.12	0.06	100.58
T575	7	93KKA1085K	purple	Cr-Pyrope	0.25-0.5	40.89	0.26	14.20	12.47	6.11	0.34	20.00	6.62	0.02	0.01	100.91
T575	8	93KKA1085K	purple	Cr-Pyrope	0.25-0.5	42.18	0.22	19.28	6.19	6.25	0.34	21.54	5.58	0.00	0.01	101.56
T575	9	93KKA1085K	purple	Cr-Pyrope	0.25-0.5	41.77	0.21	19.11	5.92	6.73	0.33	20.96	5.56	0.00	0.00	100.59
T575	10	93KKA1085K	purple	Cr-Pyrope	0.25-0.5	42.41	0.37	19.60	4.88	7.23	0.38	21.70	4.84	0.01	0.00	101.41
T575	11	93KKA1085K	ong-ppl	Pyroxene ?	0.25-0.5	54.84	0.30	17.43	3.59	5.66	0.27	19.17	4.02	0.11	0.01	105.41
T575	13	93KKA1087K	green	Cr-Diopside	0.25-0.5	54.60	0.17	1.42	1.08	2.45	0.04	17.64	21.74	1.09	0.06	100.29
T575	12	93KKA1087K	purple	Cr-Pyrope	0.25-0.5	42.25	0.16	16.95	9.15	6.41	0.29	20.66	6.19	0.01	0.01	102.08
T575	14	93KKA1092K	purple	Cr-Pyrope	0.25-0.5	41.03	0.02	16.80	9.11	6.60	0.37	20.95	4.91	0.03	0.02	99.84
T575	15	93KKA1092K	purple	Cr-Pyrope	0.25-0.5	41.90	0.57	17.70	6.65	6.94	0.32	20.86	5.96	0.01	0.00	100.90
T575	16	93KKA1092K	purple	Cr-Pyrope	0.25-0.5	42.32	0.20	20.27	4.51	6.47	0.33	21.82	4.94	0.02	0.01	100.87
T575	17	93KKA1092K	rd-ppl	Cr-Pyrope	0.25-0.5	43.06	0.35	21.58	2.78	7.25	0.31	22.10	4.36	0.03	0.00	101.82
T575	20	93KKA1092K	black	Ilmenite	0.25-0.5	0.00	49.65	0.02	0.05	46.03	1.50	0.42	0.00	0.00	0.01	97.67
T575	21	93KKA1092K	black	Ilmenite	0.25-0.5	0.00	52.14	0.02	0.02	44.22	1.92	0.22	0.00	0.01	0.01	98.56
T575	19	93KKA1092K	green	LoCr-Diopside	0.25-0.5	54.08	0.05	0.92	0.18	4.97	0.17	15.79	24.23	0.30	0.02	100.71
T575	18	93KKA1092K	green	LoCr-Diopside	0.25-0.5	54.12	0.08	1.02	0.49	5.62	0.35	16.41	21.85	0.38	0.02	100.33
T575	22	93KKA1095K	purple	Cr-Pyrope	0.25-0.5	42.20	0.00	20.37	5.53	7.92	0.39	23.22	1.38	0.03	0.00	101.04
T575	23	93KKA1095K	purple	Cr-Pyrope	0.25-0.5	42.20	0.02	20.13	5.26	7.87	0.50	22.75	1.66	0.02	0.02	100.42
T575	24	93KKA1095K	purple	Cr-Pyrope	0.25-0.5	41.96	0.04	20.13	5.36	8.03	0.60	20.38	4.82	0.00	0.00	101.32
T575	27	93KKA1098K	orange	Almandine	0.25-0.5	37.89	0.12	21.34	0.04	26.06	2.63	4.03	8.19	0.00	0.00	100.30
T575	28	93KKA1098K	orange	Almandine	0.25-0.5	37.98	0.11	21.08	0.02	21.62	3.01	1.79	14.33	0.01	0.00	99.93
T575	25	93KKA1098K	purple	Cr-Pyrope	0.25-0.5	41.54	0.05	17.89	7.91	8.18	0.57	18.26	7.09	0.00	0.00	101.48
T575	26	93KKA1098K	purple	Cr-Pyrope	0.25-0.5	42.33	0.09	19.93	4.59	7.25	0.29	21.12	5.27	0.00	0.00	100.86
T575	30	93KKA1098K	black	Ilmenite	0.25-0.5	0.00	50.53	0.03	0.04	44.52	2.98	0.03	0.00	0.00	0.01	98.12
T575	31	93KKA1098K	black	Ilmenite	0.25-0.5	0.03	50.15	0.03	0.04	45.77	2.13	0.10	0.01	0.05	0.00	98.31
T575	32	93KKA1098K	black	Ilmenite	0.25-0.5	0.00	49.79	0.02	0.03	45.39	2.09	0.02	0.00	0.04	0.02	97.38
T575	29	93KKA1098K	green	LoCr-Diopside	0.25-0.5	53.60	0.06	1.36	0.68	4.12	0.17	16.53	23.05	0.46	0.00	100.03
T575	33	93KKA1101K	purple	Cr-Pyrope	0.25-0.5	40.17	0.10	15.14	9.95	11.92	0.63	14.69	8.36	0.03	0.02	101.00
T575	34	93KKA1101K	purple	Cr-Pyrope	0.25-0.5	41.96	0.02	20.24	4.99	7.22	0.30	22.32	3.65	0.02	0.00	100.72
T575	35	93KKA1101K	purple	Cr-Pyrope	0.25-0.5	42.23	0.21	17.93	7.74	6.95	0.41	20.95	5.63	0.03	0.02	102.09

MOUNT	GRAIN	SAMPLE	COLOR	MINERAL	SIZE(mm)	SIO2	TIO2	AL2O3	CR2O3	FEO	MNO	MGO	CAO	NA2O	K2O	TOTAL
T575	36	93KKA1101K	rd-ppl	Cr-Pyrope	0.25-0.5	42.78	0.36	20.48	4.64	7.88	0.45	20.98	4.73	0.01	0.01	102.31
T575	37	93KKA1101K	purple	Cr-Pyrope	0.25-0.5	41.57	0.32	18.51	6.31	8.07	0.45	18.95	7.05	0.03	0.00	101.25
T575	39	93KKA1101K	black	Ilmenite	0.25-0.5	0.00	50.34	0.07	0.26	46.37	0.51	0.43	0.00	0.01	0.00	98.00
T575	38	93KKA1101K	green	LoCr-Diopside	0.25-0.5	55.34	0.19	1.51	0.85	3.40	0.15	18.50	19.59	1.27	0.05	100.84
T575	42	93KKA1104K	green	Cr-Diopside	0.25-0.5	54.08	0.04	1.01	1.00	3.46	0.14	16.82	22.91	0.56	0.00	100.03
T575	40	93KKA1104K	purple	Cr-Pyrope	0.25-0.5	42.49	0.18	20.51	4.55	6.60	0.28	21.81	5.38	0.02	0.00	101.81
T575	41	93KKA1104K	yl-ong	Staurolite	0.25-0.5	27.26	0.42	55.55	0.06	12.99	0.44	1.97	0.02	0.07	0.00	98.79
T575	43	93KKA1106K	purple	Cr-Pyrope	0.25-0.5	42.57	0.42	19.77	4.57	7.62	0.37	21.37	5.17	0.01	0.03	101.90
T575	44	93KKA1113K	purple	Cr-Pyrope	0.25-0.5	42.09	0.27	19.61	5.11	7.66	0.37	20.75	5.51	0.00	0.02	101.40
T575	54	93KKA1117K	green	Cr-Diopside	0.25-0.5	55.11	0.20	1.09	1.19	2.55	0.05	17.66	21.85	1.10	0.05	100.86
T575	45	93KKA1117K	purple	Cr-Pyrope	0.25-0.5	41.17	0.00	17.25	8.95	7.99	0.60	21.12	3.42	0.00	0.02	100.51
T575	46	93KKA1117K	purple	Cr-Pyrope	0.25-0.5	41.26	0.12	18.09	7.14	6.76	0.32	20.24	5.95	0.00	0.01	99.87
T575	47	93KKA1117K	purple	Cr-Pyrope	0.25-0.5	41.14	0.46	16.95	8.21	7.11	0.41	20.22	6.11	0.02	0.00	100.63
T575	48	93KKA1117K	purple	Cr-Pyrope	0.25-0.5	42.32	0.05	18.83	6.78	7.51	0.48	20.78	5.24	0.01	0.02	102.00
T575	49	93KKA1117K	purple	Cr-Pyrope	0.25-0.5	42.08	0.18	18.34	6.98	6.67	0.37	20.99	5.66	0.01	0.00	101.29
T575	50	93KKA1117K	rd-ppl	Cr-Pyrope	0.25-0.5	41.51	0.40	16.64	8.87	7.09	0.37	20.08	6.33	0.03	0.00	101.31
T575	51	93KKA1117K	rd-ppl	Cr-Pyrope	0.25-0.5	42.61	0.21	20.28	5.01	7.12	0.41	21.89	4.56	0.00	0.03	102.12
T575	52	93KKA1117K	purple	Cr-Pyrope	0.25-0.5	42.12	0.41	18.58	6.35	6.65	0.35	21.18	5.43	0.04	0.02	101.12
T575	53	93KKA1117K	rd-ppl	Cr-Pyrope	0.25-0.5	42.86	0.32	20.41	4.07	7.44	0.38	20.99	5.27	0.00	0.02	101.75
T575	55	93KKA1117K	black	Ilmenite	0.25-0.5	0.00	49.17	0.12	0.07	47.30	0.51	0.47	0.02	0.00	0.04	97.70
T575	56	93KKA1117K	black	Ilmenite	0.25-0.5	0.00	49.08	0.06	0.03	46.79	1.14	0.34	0.00	0.00	0.00	97.43
T575	57	93KKA1117K	black	Ilmenite	0.25-0.5	0.00	48.80	0.03	0.06	48.05	0.46	0.25	0.04	0.00	0.00	97.69
T575	58	93KKA1117K	black	Ilmenite	0.25-0.5	0.00	50.96	0.03	0.06	46.91	0.82	0.30	0.02	0.00	0.00	99.11
T575	59	93KKA1117K	black	Ilmenite	0.25-0.5	0.00	50.10	0.04	0.04	47.26	0.76	0.11	0.03	0.00	0.00	98.34
T575	60	93KKA1117K	black	Ilmenite	0.25-0.5	0.00	49.90	0.03	0.08	47.23	0.98	0.31	0.01	0.00	0.00	98.53
T575	61	93KKA1117K	black	Ilmenite	0.25-0.5	0.00	48.60	0.07	0.10	47.54	1.46	0.01	0.02	0.01	0.00	97.82
T575	62	93KKA1117K	black	Ilmenite	0.25-0.5	0.00	48.50	0.03	0.19	47.94	0.79	0.23	0.01	0.00	0.02	97.71
T575	63	93KKA1117K	black	Ilmenite	0.25-0.5	0.00	50.41	0.07	0.00	44.98	3.00	0.11	0.00	0.00	0.01	98.59
T628	9	93KKA1117K	purple	Cr-Pyrope	0.5-1.0	40.56	0.17	18.30	5.90	6.64	0.26	20.50	5.76	0.00	0.00	98.08
T628	10	93KKA1117K	purple	Cr-Pyrope	0.5-1.0	41.13	0.53	17.91	5.80	6.83	0.32	20.62	5.62	0.04	0.02	98.82
T576	1	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.88	0.08	19.30	5.96	8.03	0.48	19.03	6.27	0.01	0.01	101.05
T576	2	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	42.00	0.00	18.93	6.84	7.37	0.49	19.92	5.82	0.01	0.01	101.39
T576	3	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.68	0.06	19.37	6.04	7.92	0.61	19.35	6.14	0.00	0.02	101.19
T576	4	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.74	0.15	20.12	4.88	9.75	0.59	18.93	5.03	0.01	0.02	101.22
T576	5	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.75	0.18	18.68	6.82	7.68	0.52	19.55	5.73	0.01	0.01	100.92
T576	6	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	42.47	0.01	20.41	5.05	7.51	0.37	22.27	2.88	0.00	0.00	100.97
T576	7	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.49	0.10	19.12	6.23	8.50	0.57	19.37	5.37	0.00	0.00	100.76

Appendix 4

MOUNT	GRAIN	SAMPLE	COLOR	MINERAL	SIZE(mm)	SIO2	TIO2	AL2O3	CR2O3	FEO	MNO	MGO	CAO	NA2O	K2O	TOTAL
T576	8	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.40	0.10	19.45	5.66	7.79	0.49	19.48	5.85	0.02	0.02	100.26
T576	9	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.00	0.08	19.75	4.86	8.76	0.57	19.04	5.27	0.00	0.01	99.34
T576	10	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.49	0.11	19.15	6.08	7.11	0.51	20.30	5.44	0.03	0.00	100.22
T576	11	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.93	0.10	20.34	5.13	7.21	0.52	21.14	4.82	0.02	0.01	101.22
T576	12	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.73	0.09	18.57	6.59	6.62	0.39	21.18	4.26	0.05	0.01	99.48
T576	13	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.45	0.04	19.89	5.59	7.53	0.52	20.79	4.87	0.00	0.00	100.68
T576	14	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	40.69	0.19	20.59	3.34	13.26	0.82	16.33	5.37	0.01	0.01	100.61
T576	15	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.58	0.04	18.10	7.56	7.62	0.51	18.94	6.24	0.00	0.00	100.59
T576	16	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.27	0.03	18.43	7.09	8.61	0.57	18.10	6.58	0.00	0.00	100.66
T576	17	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.14	0.06	19.61	5.65	7.82	0.48	20.24	5.13	0.01	0.01	100.14
T576	18	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.46	0.08	18.85	6.56	8.80	0.56	19.01	5.46	0.00	0.00	100.78
T576	19	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.50	0.13	17.92	7.52	6.91	0.36	20.12	6.00	0.05	0.00	100.51
T576	20	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	40.93	0.05	17.93	7.56	8.59	0.62	18.19	6.95	0.00	0.03	100.85
T576	21	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.80	0.08	19.68	6.07	7.16	0.57	21.13	4.90	0.02	0.02	101.43
T576	22	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.65	0.07	19.20	6.44	7.58	0.46	19.65	6.01	0.00	0.01	101.07
T576	23	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	42.20	0.12	18.56	6.96	8.19	0.50	19.45	5.74	0.03	0.01	101.75
T576	24	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	42.41	0.00	18.95	6.97	6.90	0.43	22.86	2.84	0.01	0.00	101.37
T576	25	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	42.09	0.04	19.95	5.62	7.64	0.49	20.53	5.25	0.00	0.00	101.62
T576	26	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.76	0.05	19.97	5.60	7.66	0.48	20.18	5.26	0.00	0.01	100.96
T576	27	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.37	0.09	18.65	6.67	7.95	0.52	19.63	5.51	0.03	0.00	100.41
T576	28	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.06	0.02	18.60	7.15	7.74	0.51	19.55	5.78	0.00	0.01	100.42
T576	29	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.74	0.06	19.45	5.73	7.68	0.44	20.68	4.31	0.05	0.01	100.14
T576	30	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.33	0.15	18.25	7.03	7.58	0.42	19.63	5.97	0.06	0.00	100.42
T576	31	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.63	0.33	17.66	7.99	6.71	0.41	20.80	4.96	0.05	0.00	100.55
T576	32	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.10	0.08	18.81	6.04	8.75	0.58	18.66	6.10	0.02	0.01	100.15
T576	33	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.22	0.15	18.80	6.41	8.69	0.54	18.50	6.35	0.04	0.01	100.70
T576	34	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.44	0.04	19.31	5.78	7.17	0.41	20.61	4.98	0.04	0.03	99.81
T576	35	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	40.82	0.16	19.77	4.83	8.93	0.51	19.33	5.25	0.04	0.00	99.64
T576	36	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.40	0.20	18.58	6.93	8.54	0.54	18.84	5.86	0.04	0.02	100.93
T576	37	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.29	0.01	20.31	4.97	8.03	0.50	19.87	5.64	0.00	0.01	100.62
T576	38	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	42.01	0.08	18.60	6.88	8.37	0.58	18.29	6.44	0.00	0.00	101.25
T576	39	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	42.37	0.33	17.77	7.90	6.82	0.41	20.91	4.77	0.04	0.02	101.34
T576	40	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.61	0.15	18.60	6.32	8.16	0.65	18.42	5.49	0.03	0.01	99.43
T576	41	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.86	0.52	17.20	8.38	6.93	0.41	20.45	5.11	0.07	0.00	100.92
T576	42	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	42.36	0.05	21.29	3.59	8.49	0.45	20.20	5.18	0.04	0.00	101.64
T576	43	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	42.08	0.09	20.91	4.46	8.82	0.60	19.69	5.26	0.00	0.01	101.93
T576	44	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	42.04	0.21	20.48	4.43	8.19	0.46	20.14	5.23	0.04	0.00	101.23

Appendix 4

MOUNT	GRAIN	SAMPLE	COLOR	MINERAL	SIZE(mm)	SIO2	TIO2	AL2O3	CR2O3	FEO	MNO	MGO	CAO	NA2O	K2O	TOTAL
T576	45	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.26	0.13	19.51	5.30	11.21	0.75	17.46	5.62	0.04	0.02	101.28
T576	46	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	42.37	0.28	18.76	6.38	6.34	0.36	21.39	5.39	0.03	0.01	101.31
T576	47	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.80	0.13	19.86	5.39	7.81	0.41	20.84	4.14	0.06	0.00	100.44
T576	48	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.52	0.24	17.24	8.72	6.95	0.46	20.50	4.97	0.03	0.02	100.65
T576	49	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	42.16	0.00	19.63	6.03	7.56	0.54	20.75	4.67	0.02	0.03	101.39
T576	50	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.99	0.14	19.86	5.11	8.60	0.48	19.72	5.16	0.02	0.00	101.06
T576	51	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.78	0.30	19.99	4.67	8.64	0.49	20.28	4.54	0.05	0.01	100.77
T576	52	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.24	0.08	18.61	6.76	7.30	0.52	20.16	5.11	0.01	0.00	99.78
T576	53	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	40.95	0.22	18.81	6.35	8.75	0.64	19.10	4.97	0.05	0.00	99.84
T576	54	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.43	0.17	18.94	6.10	7.81	0.53	19.39	5.77	0.06	0.00	100.19
T576	55	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.64	0.09	19.69	5.62	8.21	0.59	19.61	5.33	0.00	0.00	100.80
T576	57	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.18	0.19	20.25	4.83	8.30	0.43	19.98	5.07	0.03	0.00	100.26
T576	58	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.29	0.20	19.70	4.83	8.52	0.50	19.10	5.38	0.04	0.00	99.56
T576	59	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.79	0.03	20.18	5.20	7.85	0.40	20.12	5.57	0.00	0.00	101.14
T576	60	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.86	0.17	20.21	4.18	8.96	0.59	19.38	5.33	0.02	0.02	100.72
T576	61	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.60	0.14	19.03	5.92	8.43	0.57	18.75	5.86	0.02	0.01	100.31
T576	62	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.48	0.18	19.59	5.47	9.06	0.52	18.88	5.56	0.06	0.02	100.81
T576	63	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.47	0.03	19.18	6.32	8.08	0.56	19.14	6.13	0.02	0.01	100.93
T576	64	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	42.07	0.10	19.23	5.98	8.74	0.64	19.75	4.75	0.02	0.01	101.29
T576	65	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.65	0.14	19.49	5.74	8.74	0.54	18.52	6.19	0.02	0.04	101.07
T576	66	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.85	0.14	20.41	5.02	8.22	0.52	19.98	5.27	0.03	0.00	101.44
T576	67	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.95	0.10	18.03	7.85	6.57	0.37	21.82	4.33	0.01	0.02	101.05
T576	68	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.56	0.15	19.12	6.63	7.18	0.51	20.36	5.75	0.02	0.00	101.27
T576	69	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.23	0.31	18.10	7.02	8.86	0.59	18.31	6.17	0.01	0.00	100.61
T576	70	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.20	0.10	20.19	4.86	8.46	0.51	19.47	5.39	0.03	0.01	100.21
T576	71	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	42.25	0.42	18.54	6.73	7.13	0.39	20.88	5.14	0.08	0.02	101.57
T576	72	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.37	0.26	20.55	3.89	9.19	0.56	19.51	4.96	0.07	0.01	100.36
T576	73	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.31	0.10	21.00	3.51	9.13	0.50	19.53	5.17	0.03	0.00	100.29
T576	74	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.16	0.58	18.05	6.80	7.63	0.39	20.27	5.08	0.09	0.00	100.05
T576	75	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	42.12	0.30	19.84	4.72	8.08	0.43	20.58	4.34	0.06	0.01	100.48
T576	76	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	40.86	0.31	18.37	6.42	9.30	0.57	18.41	6.01	0.01	0.00	100.26
T576	77	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.05	0.18	19.07	5.76	8.17	0.50	19.41	5.59	0.06	0.00	99.78
T576	78	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	40.80	0.28	19.61	4.98	8.65	0.45	20.48	4.45	0.10	0.01	99.80
T576	79	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	41.53	0.30	19.98	4.78	8.39	0.55	19.95	4.36	0.08	0.01	99.92
T576	80	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	40.79	0.30	19.68	4.88	8.54	0.52	20.40	4.44	0.06	0.00	99.61
T576	81	93KKA1119K	rd-ppl	Cr-Pyrope	0.25-0.5	41.38	0.16	18.69	6.42	8.39	0.60	18.89	5.58	0.04	0.02	100.16
T576	82	93KKA1119K	rd-ppl	Cr-Pyrope	0.25-0.5	40.86	0.44	18.65	5.68	7.85	0.30	20.77	4.91	0.08	0.03	99.56

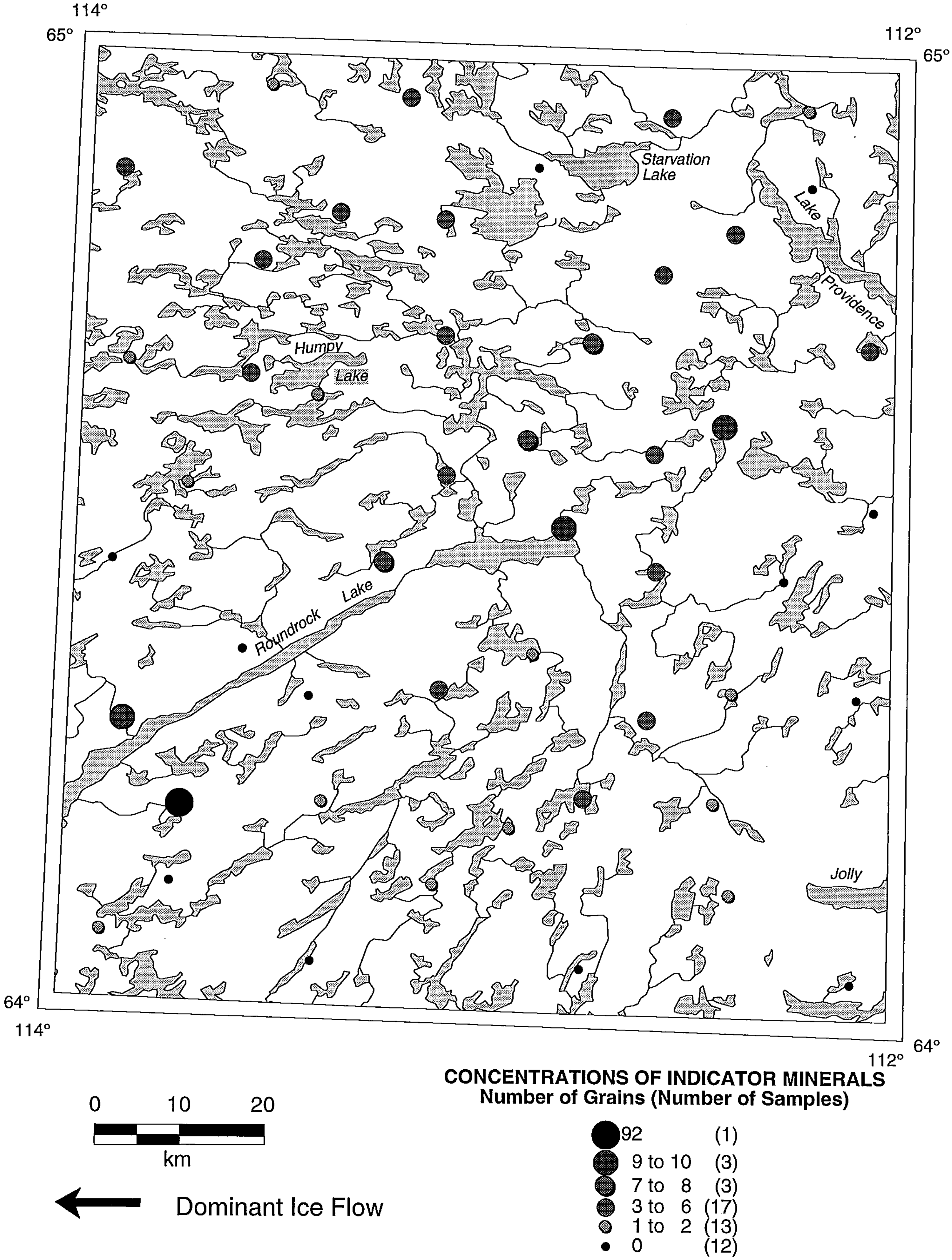
Appendix 4

MOUNT	GRAIN	SAMPLE	COLOR	MINERAL	SIZE(mm)	SIO2	TIO2	AL2O3	CR2O3	FEO	MNO	MGO	CAO	NA2O	K2O	TOTAL
T576	83	93KKA1119K	rd-ppl	Cr-Pyrope	0.25-0.5	40.74	0.26	19.37	4.74	11.88	0.49	17.14	5.67	0.04	0.00	100.32
T576	84	93KKA1119K	rd-ppl	Cr-Pyrope	0.25-0.5	41.55	0.30	20.58	3.77	8.69	0.39	20.05	5.01	0.02	0.01	100.36
T576	85	93KKA1119K	rd-ppl	Cr-Pyrope	0.25-0.5	41.82	0.29	20.72	3.77	7.43	0.38	20.98	4.82	0.07	0.02	100.30
T576	86	93KKA1119K	rd-ppl	Cr-Pyrope	0.25-0.5	41.53	0.10	19.60	5.97	8.28	0.62	19.76	5.00	0.02	0.00	100.88
T576	87	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	42.00	0.19	19.97	5.32	7.97	0.47	19.98	5.12	0.02	0.01	101.05
T576	88	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	42.07	0.09	19.92	5.25	7.43	0.49	21.43	3.63	0.04	0.01	100.35
T576	89	93KKA1119K	purple	Cr-Pyrope	0.25-0.5	42.48	0.04	21.28	4.32	7.35	0.48	22.87	2.43	0.04	0.00	101.28
T576	94	93KKA1119K	black	Ilmenite	0.25-0.5	0.00	50.48	0.06	0.04	46.73	1.81	0.11	0.03	0.04	0.00	99.31
T576	95	93KKA1119K	green	LoCr-Diopside	0.25-0.5	52.99	0.03	0.68	0.36	4.75	0.21	15.69	23.86	0.50	0.00	99.05
T576	90	93KKA1119K	black	Mg-Ilmenite	0.25-0.5	0.05	51.66	0.49	0.44	34.25	0.24	10.95	0.02	0.02	0.01	98.12
T576	91	93KKA1119K	black	Mg-Ilmenite	0.25-0.5	0.00	49.13	0.32	1.19	37.76	0.33	8.70	0.02	0.02	0.01	97.50
T576	92	93KKA1119K	black	Mg-Ilmenite	0.25-0.5	0.00	49.86	0.45	0.37	37.51	0.29	9.10	0.01	0.03	0.00	97.60
T576	93	93KKA1119K	black	Mg-Ilmenite	0.25-0.5	0.00	50.94	0.51	3.34	31.51	0.22	11.47	0.00	0.01	0.01	98.01
T576	56	93KKA1119K		*missed grain*	0.25-0.5	0.04	0.00	0.01	0.02	0.00	0.00	0.03	0.00	0.03	0.00	0.12
T628	11	93KKA1119K	purple	Cr-Pyrope	0.5-1.0	40.62	0.08	17.35	8.08	6.61	0.39	20.59	4.92	0.07	0.00	98.71
T628	12	93KKA1119K	purple	Cr-Pyrope	0.5-1.0	39.96	0.02	19.10	5.73	7.88	0.48	19.07	5.72	0.00	0.01	97.97
T628	13	93KKA1119K	purple	Cr-Pyrope	0.5-1.0	40.12	0.08	18.50	6.50	7.97	0.50	18.66	6.20	0.02	0.01	98.55
T628	14	93KKA1119K	purple	Cr-Pyrope	0.5-1.0	39.86	0.18	18.68	5.96	9.07	0.53	18.27	5.84	0.05	0.01	98.44
T628	15	93KKA1119K	purple	Cr-Pyrope	0.5-1.0	40.04	0.04	19.12	5.66	7.88	0.48	19.53	5.24	0.00	0.00	97.98
T628	16	93KKA1119K	purple	Cr-Pyrope	0.5-1.0	40.53	0.00	19.32	5.50	7.83	0.53	20.77	3.80	0.00	0.01	98.29
T628	17	93KKA1119K	purple	Cr-Pyrope	0.5-1.0	40.78	0.27	18.42	6.64	7.13	0.44	20.70	4.25	0.09	0.00	98.72
T628	18	93KKA1119K	purple	Cr-Pyrope	0.5-1.0	40.20	0.16	18.57	6.61	7.92	0.47	19.43	5.38	0.00	0.01	98.75
T628	19	93KKA1119K	rd-ppl	Cr-Pyrope	0.5-1.0	40.44	0.19	20.51	3.16	8.98	0.56	19.84	4.00	0.04	0.01	97.73
T628	20	93KKA1119K	rd-ppl	Cr-Pyrope	0.5-1.0	40.38	0.10	20.04	4.22	9.28	0.56	18.53	5.48	0.00	0.04	98.62
T628	21	93KKA1119K	rd-ppl	Cr-Pyrope	0.5-1.0	39.22	0.13	20.20	2.27	16.10	0.80	14.49	5.09	0.01	0.01	98.31
T628	22	93KKA1119K	black	Mg-Ilmenite	0.5-1.0	1.45	48.17	0.35	0.96	36.88	0.33	8.86	0.04	0.00	0.00	97.04
T628	23	93KKA1119K	black	Mg-Ilmenite	0.5-1.0	1.75	50.64	0.47	0.53	34.14	0.23	9.45	0.04	0.03	0.02	97.30
T628	24	93KKA1119K	black	Tourmaline	0.5-1.0	35.58	0.25	32.95	0.03	13.06	0.23	1.97	0.13	1.78	0.03	86.00
T575	64	93KKA1122K	purple	Cr-Pyrope	0.25-0.5	40.23	0.20	15.44	10.51	7.08	0.38	19.09	6.80	0.07	0.02	99.83
T575	65	93KKA1122K	black	Ilmenite	0.25-0.5	0.00	44.63	0.09	0.05	52.41	0.60	0.22	0.01	0.00	0.00	98.02
T575	66	93KKA1122K	black	Ilmenite	0.25-0.5	0.00	50.22	0.03	0.02	46.59	1.71	0.09	0.02	0.03	0.01	98.73
T575	67	93KKA1122K	black	Ilmenite	0.25-0.5	0.00	50.12	0.07	0.04	46.70	1.68	0.11	0.01	0.00	0.01	98.73

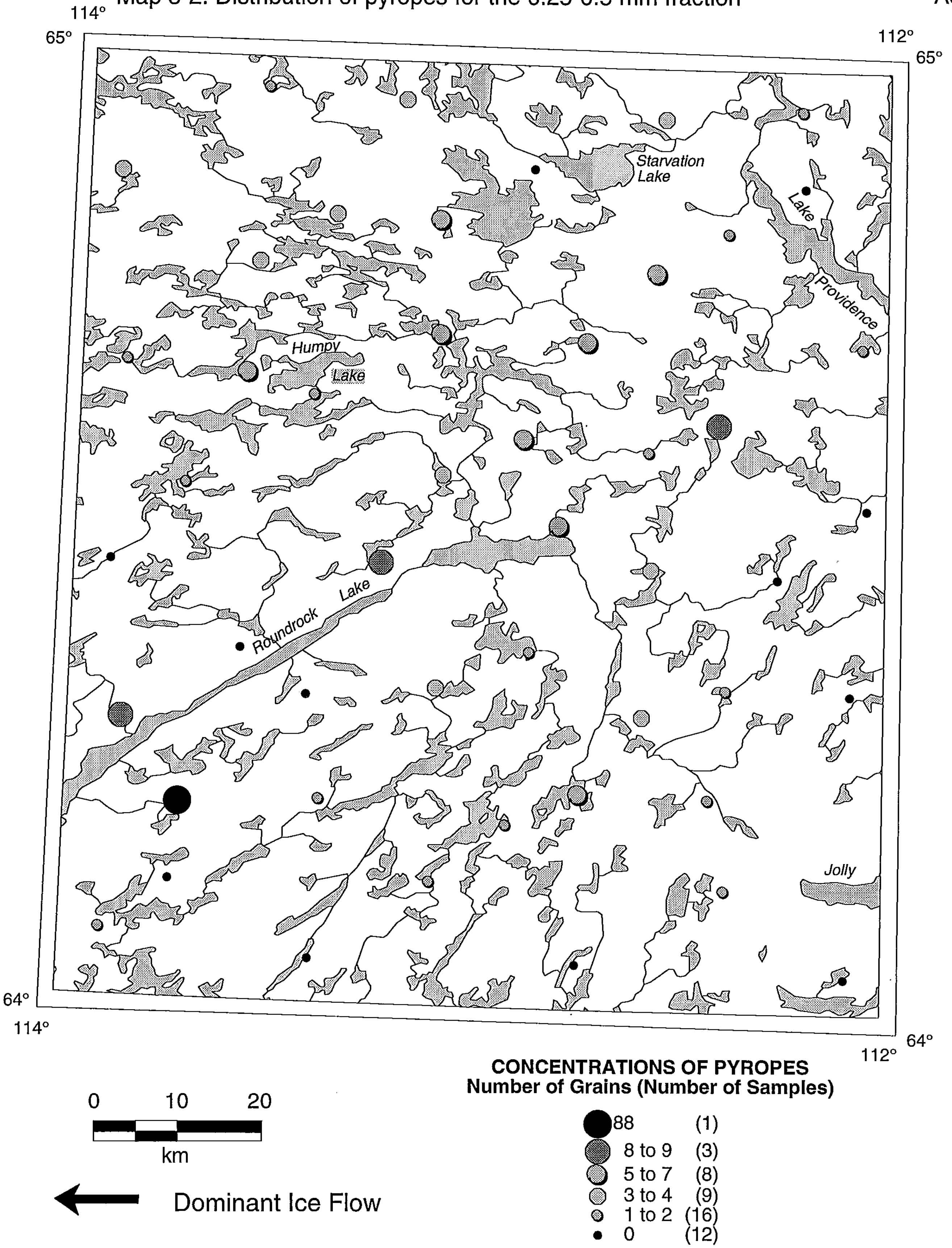
APPENDIX 5

KIMBERLITE INDICATOR MINERAL DISTRIBUTION MAPS FOR THE WINTER LAKE AREA

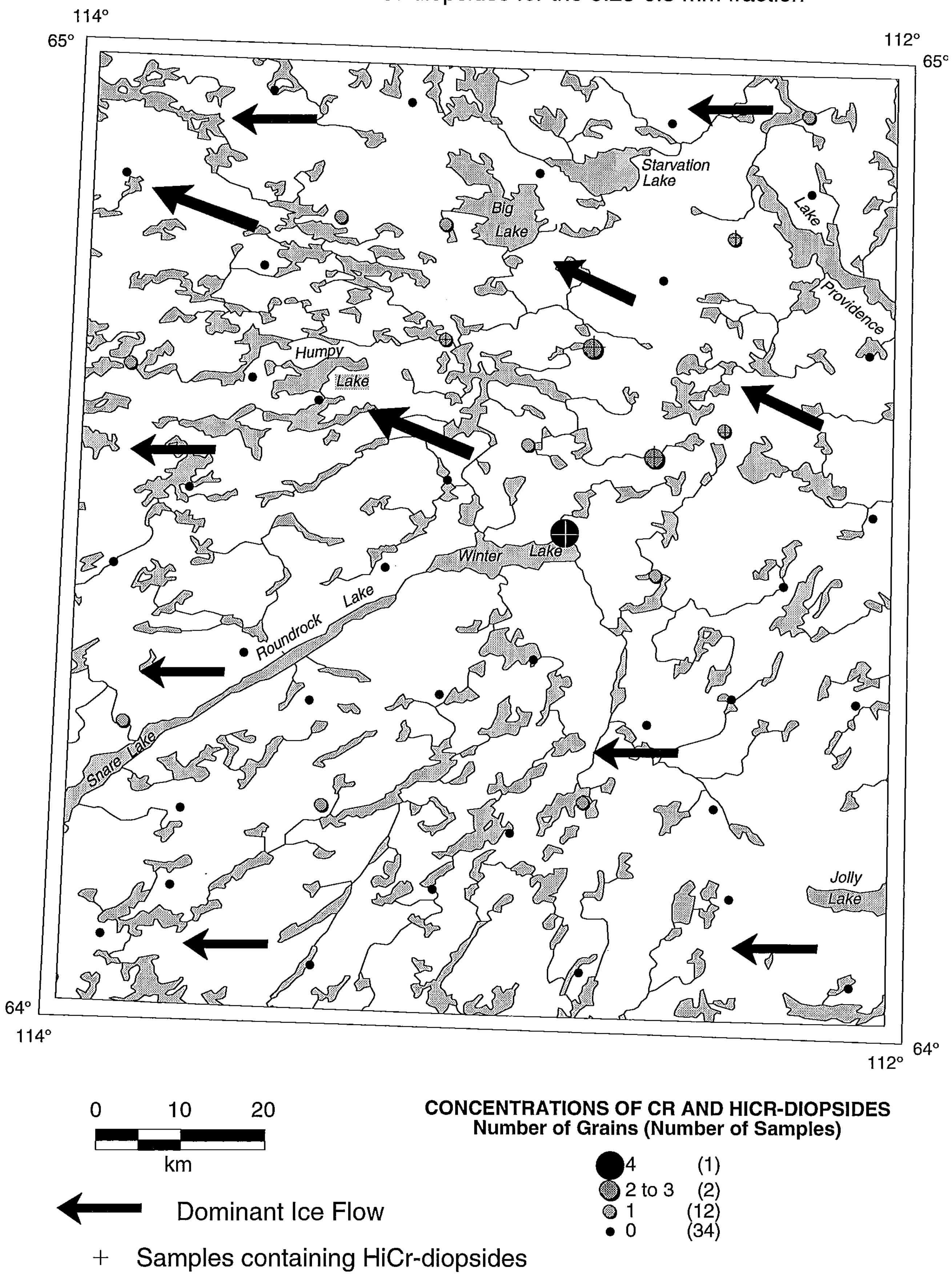
Map 5-1: Distribution of kimberlite indicator minerals for the 0.25-0.5 mm fraction



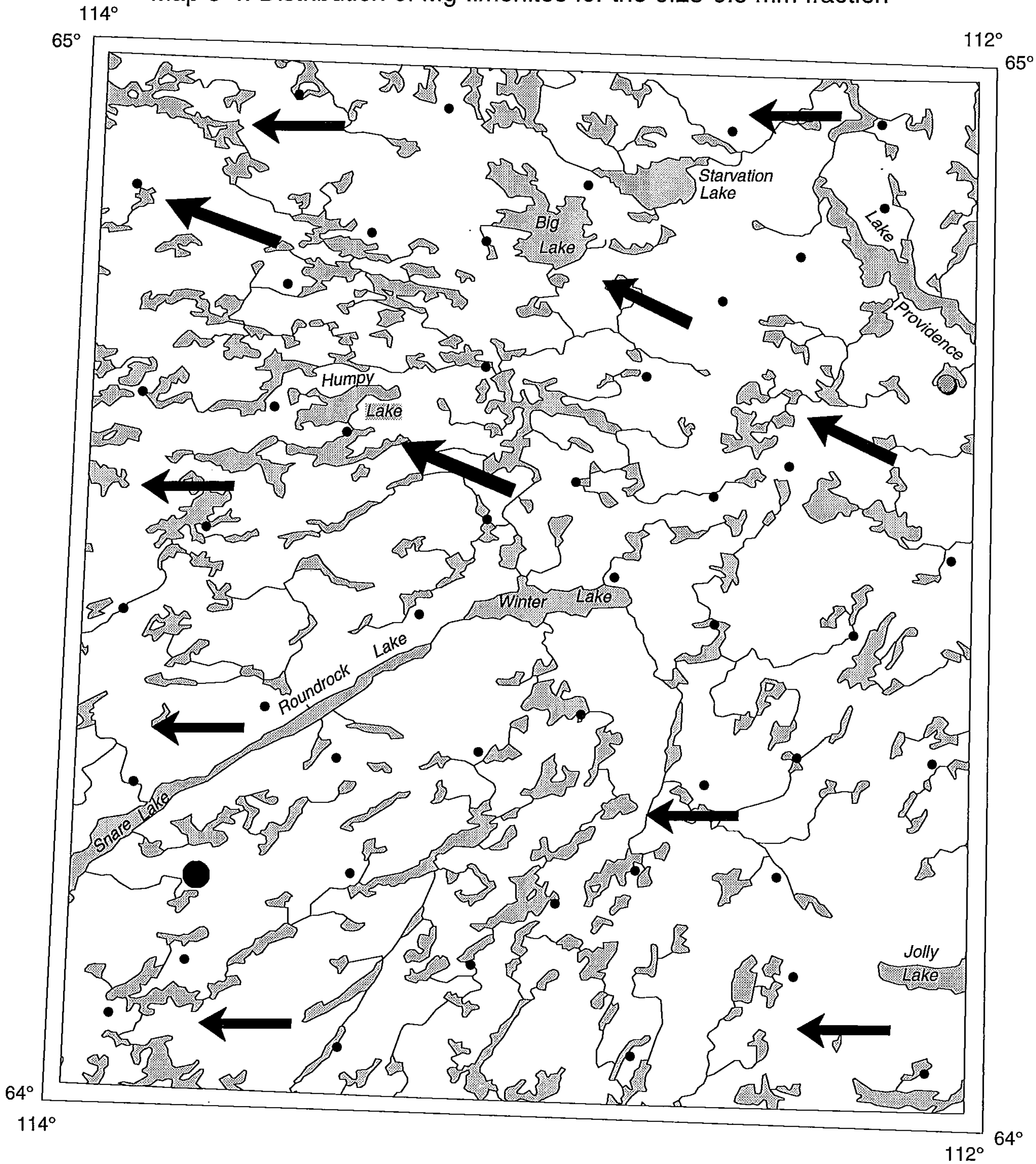
Map 5-2: Distribution of pyropes for the 0.25-0.5 mm fraction



Distribution of Cr and HiCr-diopsides for the 0.25-0.5 mm fraction



Map 5-4: Distribution of Mg-Ilmenites for the 0.25-0.5 mm fraction



0 10 20

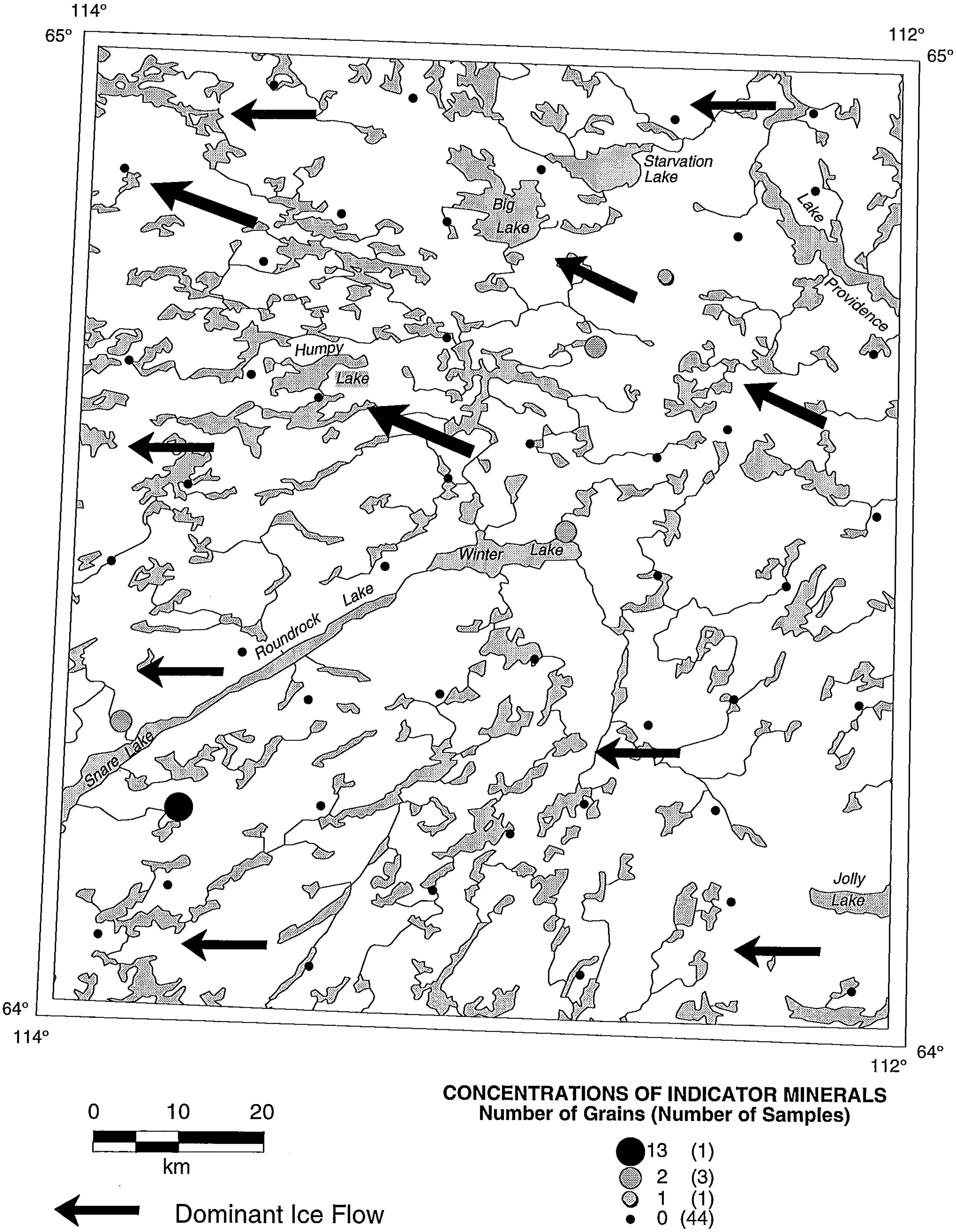
km

Dominant Ice Flow

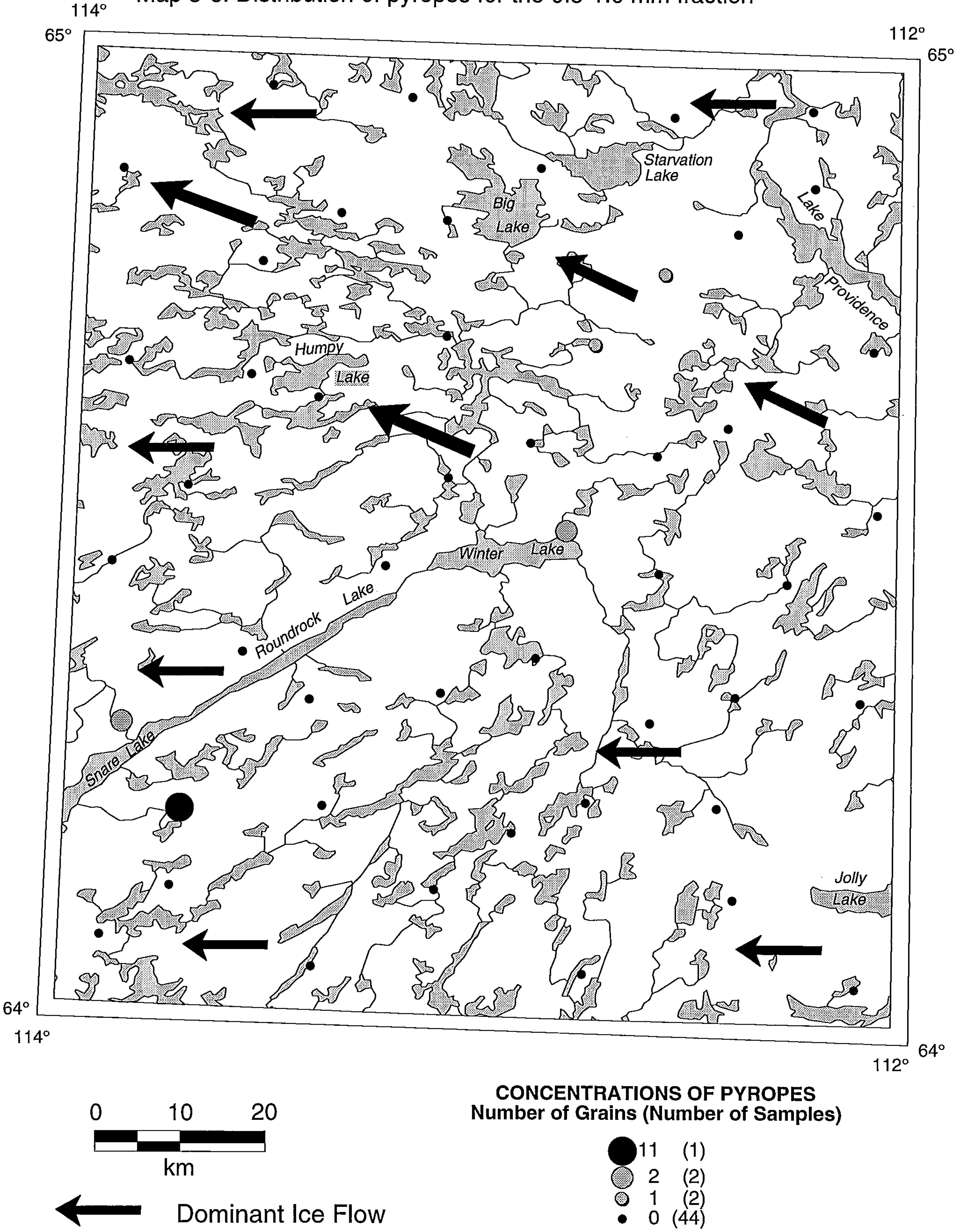
CONCENTRATIONS OF MG-ILMENITES
Number of Grains (Number of Samples)

4 (1)
1 (1)
0 (47)

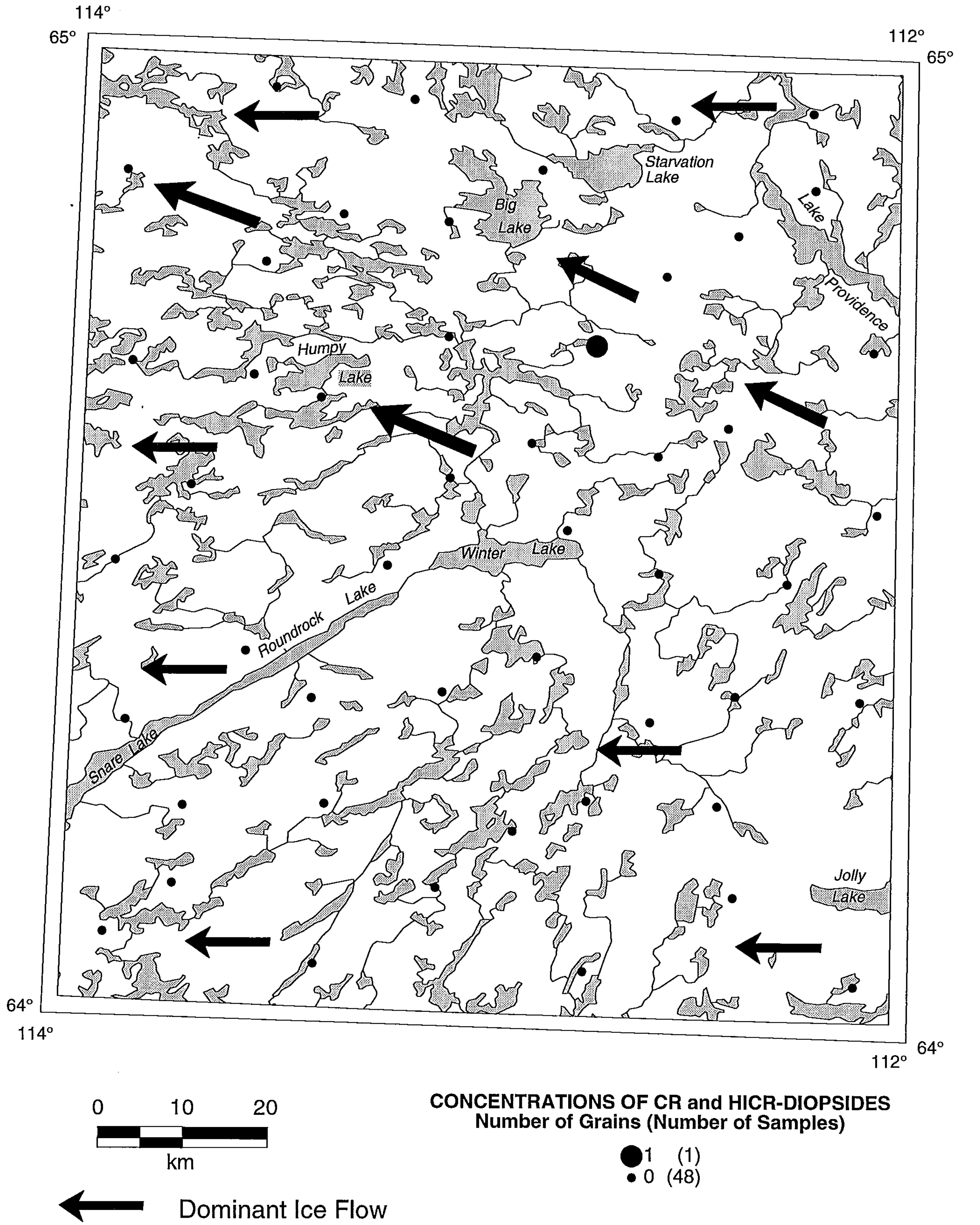
Map 5-5: Distribution of kimberlite indicator minerals for the 0.5-1.0 mm fraction



Map 5-6: Distribution of pyropes for the 0.5-1.0 mm fraction



Map 5-7: Distribution of Cr and HiCr-diopsides for the 0.5-1.0 mm fraction



Map 5-8: Distribution of Mg-ilmenites for the 0.5-1.0 mm fraction