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Cover Photo: Weathered fragment of kimberlite found in bedded sands in the upper portion of the east flank of the esker with a thick (1 m) stratified deposit of coarse pebbly and cobbly sands overlying well sorted crossbedded and planar-bedded medium-coarse sand.

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INDICATOR MINERALOGY OF A KIMBERLITE COBBLE FROM AN ESKER ON THE SOUTHEASTERN FLANK OF THE BUFFALO HEAD HILLS, NORTHERN ALBERTA

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ABSTRACT

This report describes the indicator mineral abundance and composition of kimberlite cobble 03-MPB-009 from an esker on the southeast flank of the Buffalo Head Hills, northern Alberta. The Buffalo Head Hills kimberlite field consists of 38 kimberlites intruded into poorly indurated Cretaceous host rocks. The source esker is the 2 km southern segment of a discontinuous chain of ice-contact sediments extending 7 km to the north. Numerous kimberlite fragments have been recovered from pits in this esker segment since 1997. Olivine and chromite are the most abundant indicator minerals in the kimberlite cobble, Cr-pyrope and Cr-diopside occur only in minor amounts and Mg-ilmenite is absent. The cobble also contains pink chromian corundum and hercynite (Mg, Fe-Al-spinel), which are known minor minerals in Buffalo Head Hills' kimberlites and can also be used as kimberlite indicator minerals in the region. The indicator mineral suite found in the cobble confirms the presence of several lithologies of mantle xenoliths in the Buffalo Head Hills kimberlites: fertile garnet-lherzolite and garnet-harzburgite, sheared garnet-lherzolite, garnet-wehrlite, garnet-pyroxenite, garnet-websterite, Group II eclogite, spinel lherzolite and chromian corundum-bearing high Al assemblages that also include Mg-Al-spinel. Although several studies document mantle xenolith and indicator mineral compositions from some of the Buffalo Head Hills kimberlites, insufficient data are available to characterize the indicator mineral abundance and composition of individual kimberlites in the Buffalo Head Hills field. Thus comparison between the kimberlite cobble studied here and potential source kimberlites is vague and the cobble's source cannot be determined. Southward paleocurrent flow directions for the host glaciofluvial sand deposits combined with late-stage ice flow towards the southeast and south suggest that the likely up-flow direction to search for the cobble's source is north. The nearest kimberlites up-flow and up-ice are K5, K6, and K14, and one of these may be the bedrock source of the cobble.

INTRODUCTION

The Buffalo Head Hills kimberlite field in northern Alberta was discovered in 1997. Since that time, a total of 38 kimberlite bodies (Fig. 1) have been discovered and characterized using a variety of techniques that have included regional airborne geophysical surveys followed by helicopter-borne and ground geophysical surveys, heavy mineral sampling, drilling, and kimberlite mini-bulk and bulk sampling. The field differs from other Canadian kimberlite fields in that the Cretaceous host rocks are much younger and are poorly indurated as compared to host rocks of kimberlite fields in the Canadian Shield or the Hudson Bay Lowlands. Some of the kimberlites form positive relief landforms that resisted erosion throughout the Tertiary and Quaternary, and in some places outcrop. At least two glacial events have affected the Buffalo Head Hills and the Quaternary sediments overlying the kimberlites are often much thicker than in other Canadian fields. The Late Wisconsin glacial and deglacial ice-flow history for the Buffalo Head Hills is also very complex.

The tills in the Buffalo Head Hills are very fine grained (34% silt and 31% clay) and heavy mineral poor, yet till and stream sediment sampling for recovery of kimberlite indicator minerals are still useful exploration methods for kimberlites (Eccles et al., 2001; Friske et al., 2003; Prior et al., 2005). Examination of kimberlite cobbles and pebbles found in esker sediments may also be a useful exploration method in this region. Studies of kimberlite clasts found in eskers from other kimberlite fields have demonstrated the value of kimberlite clast mineralogy for the identification of new kimberlite exploration targets (McClenaghan et al., 2002, 2006; Kjarsgaard et al. 2004). Also, studies of kimberlite clasts in eskers have documented distances of glaciofluvial transport, an important factor that should be considered when interpreting stream sediment indicator mineral data for streams near eskers in Buffalo Head Hills. The purpose of this report is to describe the indicator mineral size range, abundance, and chemistry of one kimberlite cobble from an esker southeast of the K4 kimberlite bodies (A,B,C), on the southeast flank of the Buffalo Head Hills (Fig. 2).

LOCATION AND PHYSIOGRAPHY

The Buffalo Head Hills consists of a relatively flat upland at an average elevation approximately 750 m a.s.l. (above sea level) with hummocky terrain dissected by meltwater channels (Fig. 2). Outcrops of

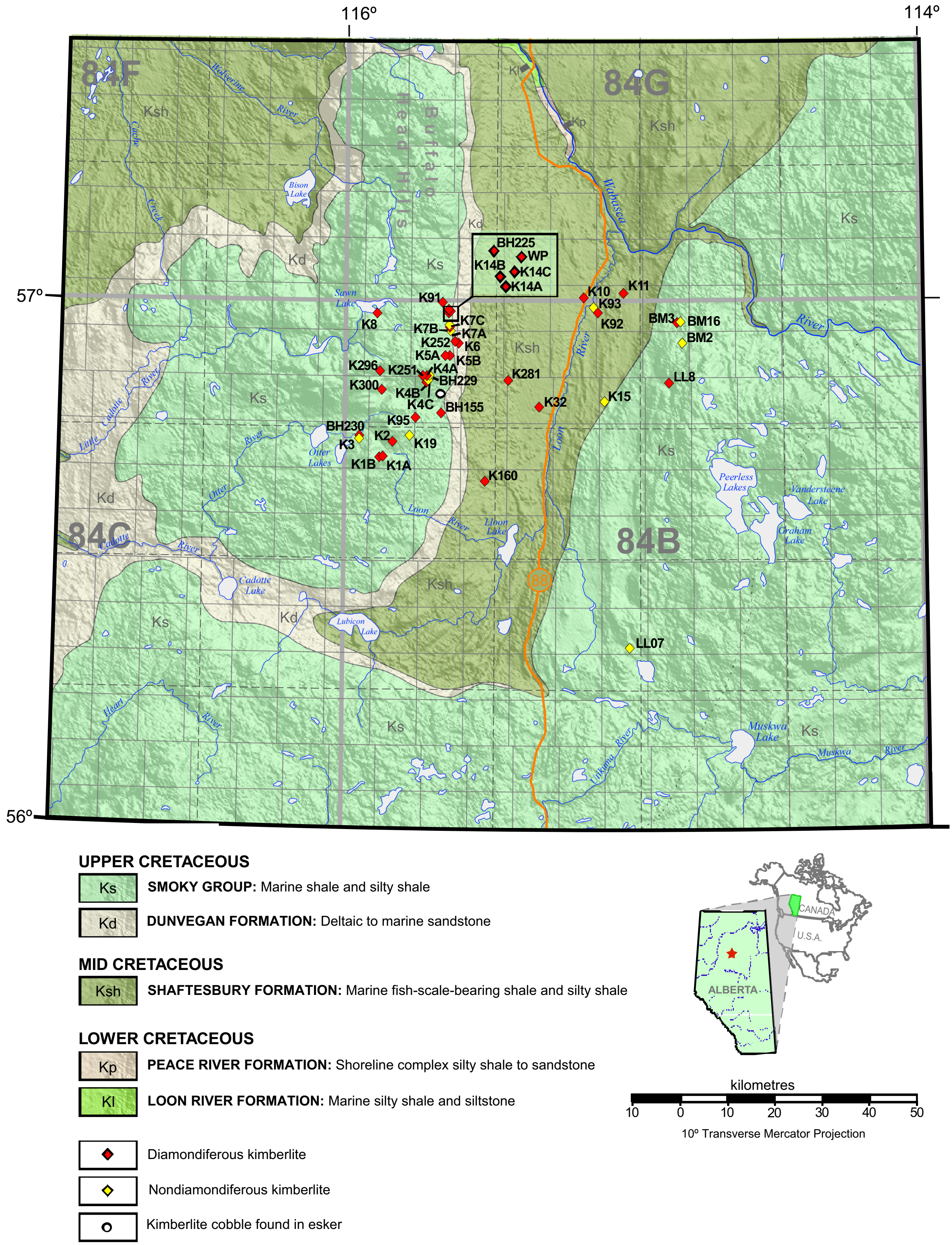

Figure 1. Regional bedrock geology, location of kimberlite bodies, and the kimberlitic cobble site in the Buffalo Head Hills kimberlite field, northern Alberta.

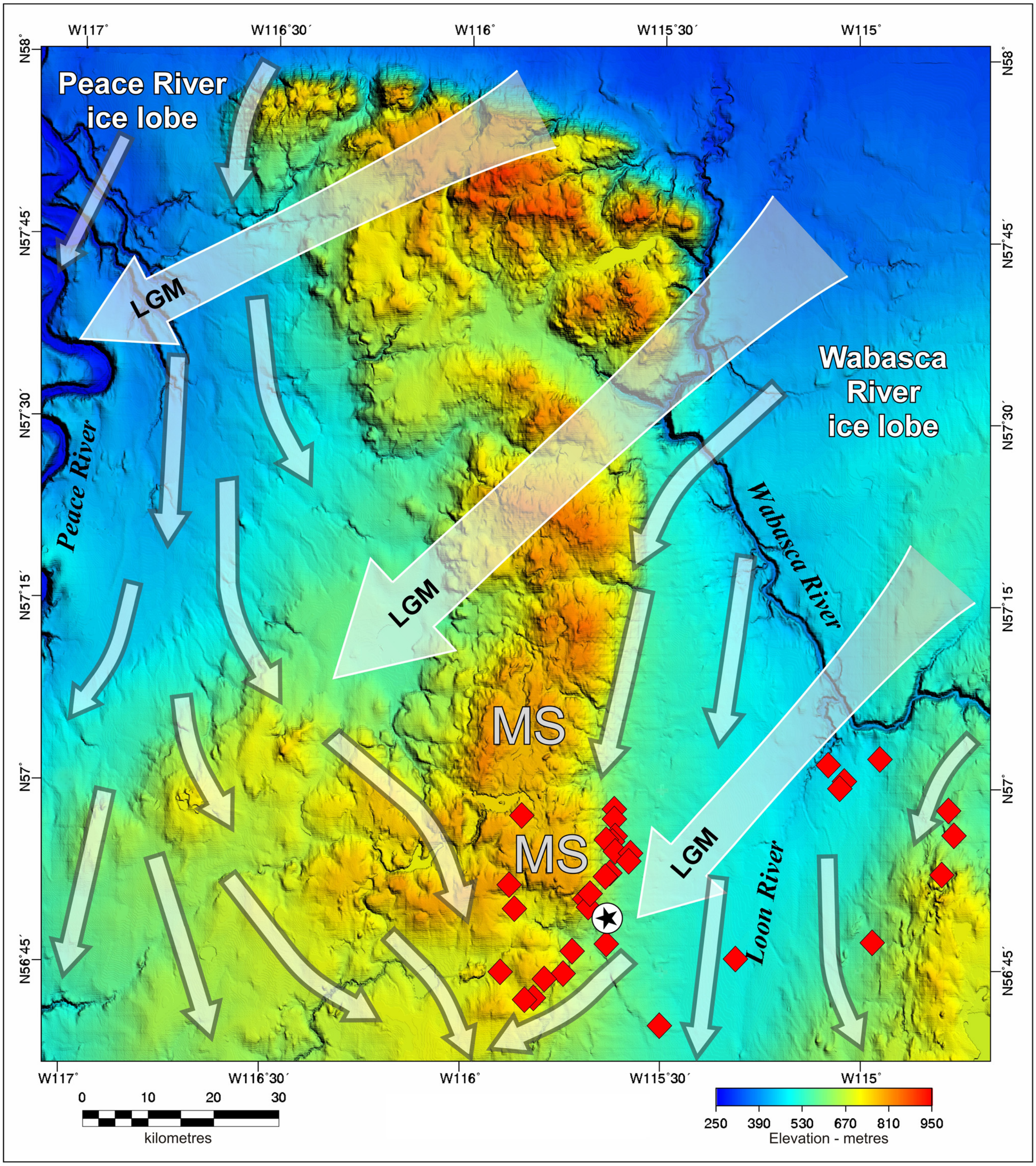

Figure 2. Reconstruction of the Late Wisconsin Laurentide Ice Sheet flow patterns for the Buffalo Head Hills kimberlite field. Large arrows (labeled LGM) represent flow during the late glacial maximum, and smaller arrows are flow paths from the Peace River and Wabasca River ice lobes during various stages of deglaciation (modified from Paulen and McClenaghan, in press). The central part of the Buffalo Head Hills experienced ice stagnation during deglaciation and this region (labeled MS) is usually mantled by thick (>2 m) deposits of ablation and melt-out till. Individual kimberlite bodies are indicated by the red diamonds, and the esker containing the kimberlite cobbles is denoted by the solid white circle.

kimberlite occur in the Buffalo Head Hills, forming small prominent knobs above the surrounding hummocky topography. Several short discontinuous eskers occur along the southeastern flank of the Buffalo Head Hills Upland (Pettapiece, 1986). Small aggregate pits have been used to extract sand and gravel from these eskers, allowing access to observe esker structure and the clasts they contain. To date, kimberlite clasts have

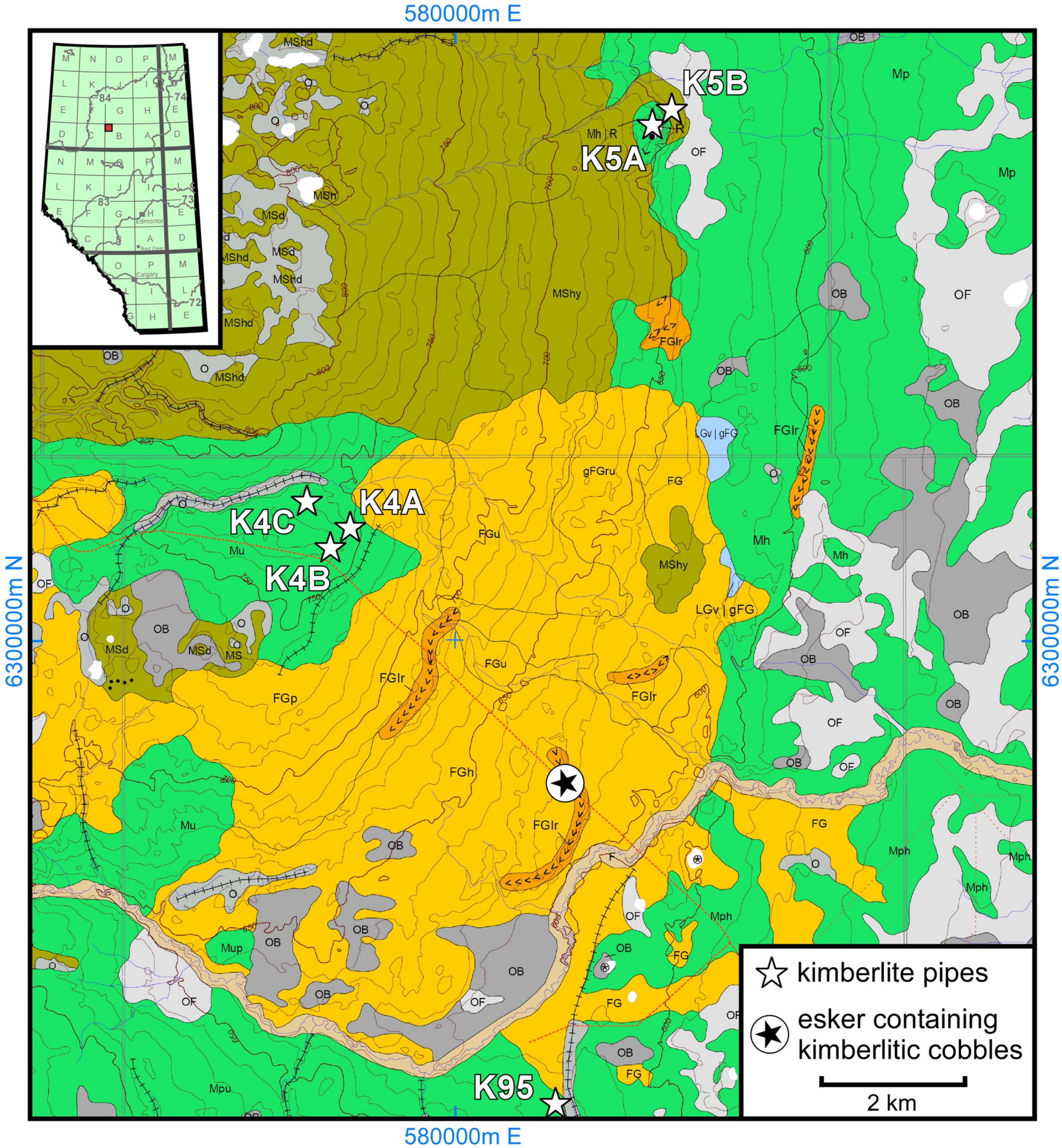

Figure 3. Portion of the Sawn Lake map sheet (NTS 84B/13) showing the surficial geology (Trommelen et al., 2006), the locations of the kimberlites, and the esker containing kimberlitic cobbles. The simplified surficial geology is summarized here: olive green units represent ablation and melt-out till (ice-stagnation deposits); emerald green unit - basal till; orange unit - glaciofluvial sediments; dark orange unit - ice-contact glaciofluvial sediments; grey unit - various types of organic sediment; and light brown unit - alluvium.

been found in one esker, the southern-most esker that occurs in this region, approximately 4 km southeast of the K4B kimberlite (Fig. 3).

BUFFALO HEAD HILLS KIMBERLITE FIELD

In the mid 1990s, while exploring for hydrocarbons in the Red Earth Creek area along the east flank of the Buffalo Head Hills, geophysicist Robert Pryde with Alberta Energy Company (AEC) identified magnetic anomalies coincident with seismic disruptions and suggested they were potential kimberlite bodies. AEC then sought and formed a joint venture with Ashton Mining of Canada Inc. (now Stornoway Diamonds Corp.) and Pure Gold Resources Ltd., with Ashton as operator. In 1997, Ashton Mining discovered kimberlite on the southeast flank of Buffalo Head Hills. As of early 2006, they have discovered 38 kimberlitic pipes in this region (Fig. 1). At least 26 of the 38 pipes in the field are diamondiferous and three pipes contain estimated grades at greater than 11 carats per hundred tonnes (cpht). The K252 kimberlite yielded the most encouraging results to date; a 22.8 tonne mini-bulk sample returned a total of 12.54 carats of diamonds for an estimated diamond content of 55.0 cpht (Ashton Mining of Canada Inc., 2001). In addition, a 0.94 carat stone shows the potential of K252 to host commercial-sized stones.

Inferred sizes of the bodies based on geophysical signatures and drilling range from <1 ha to approximately 50 ha in diameter. With the exception of one body (BM2 kimberlite, Fig. 1), the kimberlites can generally be described as volcaniclastic olivine-rich kimberlite with varying amounts of lapilli and xenoliths (Carlson et al., 1999; Skelton et al., 2003). The BM2 kimberlite exhibits hypabyssal textures. The phenocryst mineral suite of these kimberlites includes olivine, phlogopite, spinel, and perovskite. Country rock xenoliths, such as mudstone, sandstone, and limestone, are common. Xenoliths of basement and mantle material are present but rare, and include peridotitic (lherzolite, wehrlite and harzburgite), pyroxenitic, eclogitic, and corundum- and spinel-bearing rock types. New Rb-Sr phlogopite and U-Pb perovskite age determinations for 12 of 38 known ultramafic bodies in the Buffalo Head Hills show that kimberlitic magmatism occurred in at least two separate episodes during Late Cretaceous and Paleocene time (Heaman et al., 2003; Eccles et al., in press). Nine kimberlites yield ages of between 88 ± 5 Ma (U-Pb perovskite, K5A) and 81.2 ± 2.3 Ma (Rb-Sr phlogopite, K252). A U-Pb perovskite isochron age of 63.5 ± 0.7 Ma was obtained for the BM2 kimberlite, and Rb-Sr ages of 59.6 ± 2.8 Ma and 60.3 ± 0.8 Ma were determined for the K1A and K19 bodies, respectively. The ca. 88 to 81 Ma group generally occurs in the northwestern part of the field. The ca. 64 Ma BM2 body represents the only known occurrence of hypabyssal-facies kimberlite in this field and is not diamond bearing. The ca. 60 Ma group occurs in the southwestern part of the field.

Indicator mineral assemblages have been assessed from 26 kimberlites in the Buffalo Head Hills (Hood and McCandless, 2004). A variety of xenocrystic minerals are present in these kimberlites with forsteritic olivine constituting over 95% of the minerals recovered from the heavy mineral concentrates followed by Cr-pyrope, chromite, eclogitic pyrope-almandine, Ti-pyrope, Cr-augite/diopside, Mg-Cr-Al spinel, and Mg-ilmenite.

QUATERNARY GEOLOGY

Glacial advances in northern Alberta originated from the Laurentide Ice Sheet, which generally flowed across north-central Alberta in a southwesterly direction (Fig. 2) (Fulton, 1989). Fenton et al. (2006) discuss evidence for multiple glacial events that affected the Buffalo Head Hills kimberlite field. Older tills in the region, tentatively assigned to the Burke Lake Glaciation (Fenton, 1984), containing kimberlite indicator minerals were distinguished from Late Wisconsin tills by preserved weathered horizons, matrix geochemistry, and matrix carbonate content.

According to regional-scale studies, ice of the Lostwood Glaciation (Fenton, 1984) advanced to its maximum Late Wisconsin (marine isotope stage 2) limit approximately 23 to 24 ^{14}C ka BP (Dyke et al., 2002) and retreated from the Buffalo Head Hills by 11 ^{14}C ka BP (Dyke et al., 2003; Dyke, 2004). Locally, the Late Wisconsin Laurentide Ice Sheet advanced across the region in a southwesterly direction during glacial maximum (LGM, Fig. 2), as indicated by the large sculpted crag-and-tail feature at the K5 kimberlite outcrop and south-southwest-trending striae on a polished surface of the K6 kimberlite outcrop. Poorly developed flutings were formed in the highest part of the Buffalo Head Hills, where the surficial sediments form a thin veneer (<2 m) over the Cretaceous mudstone and pre-Laurentide (Tertiary to Quaternary) gravels (Paulen et al., 2003). During the early phases of deglaciation, the southwardly flowing Peace River ice lobe (Mathews, 1980) advanced out of the Peace River valley and flowed southeast over the southwestern flank of the Buffalo Head Hills. This southeasterly surge was deflected southward when it met a large mass of surging ice of the Wabasca River ice lobe (Paulen and McClenaghan, in press) that was flowing south-southwest down the Loon River Plain (Fig. 2). These deflections occurred prior to ice stagnation in the upland areas of the Buffalo Head Hills. It was during these late glacial stages that the short discontinuous eskers formed on the Buffalo Head Hills.

The main glacial erosion and transport of kimberlitic debris likely occurred during the LGM (southwestward dispersal), but palimpsest dispersal patterns and inherited indicator minerals from older tills are suspected in this region. Interpreting the provenance of kimberlitic clasts found within the glaciofluvial sediments, and in nearby modern stream sediments must not rely solely on Late Wisconsin ice and meltwater flow paths. Possible (and multiple) earlier phases of glacial erosion, transport, and deposition and the subsequent glaciofluvial erosion of till, and transport and deposition of ice-contact sediments must also be considered.

Eskers

Eskers in the Buffalo Head Hills form short (<4 km), sometimes discontinuous, ridges (Fig. 3) that were likely formed in short R-channels draining to tunnel

Figure 4. Exposure on the eastern flank of the predominantly sand esker, where section B (Fig. 10) was logged in 2004.

channels in regionally stagnant ice. Brennand (2000) classifies this type of subglacial form as Type III eskers, which are common in central and southern Alberta (Shetsen, 1987, 1990). The eskers have subdued morphology and are dominantly sand with clast content ranging from 5 to 25% and minor cobbles occurring as a thin lag at or near the esker surface (Fig. 4).

The esker containing kimberlitic fragments is about 2 km long and is the southernmost segment of a discontinuous chain of ice-contact sediments extending 7 km to the north. The sample site is located at UTM (NAD83, Zone 11) 581546E and 6298144W (Appendix A). It is on the east flanks of the Buffalo Head Hills, adjacent to a small unnamed creek containing abundant kimberlite indicator minerals (Friske et al., 2003). This esker has been periodically mined as a local source of granular aggregate, but its high sand content does not make it an ideal large-volume aggregate deposit. Kimberlite pebbles were first discovered in this esker in the summer of 1997 by Ashton Mining exploration geologists (Dave Skelton, pers. comm. 2002). Since then, minor erosion of the exposed pit walls and ongoing extraction of sand and gravel have revealed abundant kimberlitic fragments ranging in size from small pebbles (<2 cm diameter) to cobbles (15 cm) (Fig. 5)

The esker is being mined from its eastern flank, exposing over 8 m of ice-contact sediment. Exposures in the pit show typical ice-contact depositional structures, such as planar and minor trough crossbedded gravels and sands. Larger scale (up to 1 m) trough scour and fill structures also occur (Fig. 6). Individual beds range in thickness from <0.02 m up to 0.2 m with degrees of sorting varying from well sorted planar sand beds to moderately coarse gravel beds with up to 25% clasts (of >4 mm) (Fig. 7). Generally, the glaciofluvial sediments coarsen upwards from well sorted medium-grained sand to coarse granular, pebbly sand. The core of the esker has a slightly higher clast content and less sorting than the flanks. The surface of the esker has a 0.15 to 0.75 m thick lag consisting of coarse pebbly to cobbly massive gravel to poorly stratified oxidized gravel ranging from 10 to 40% clasts (Fig. 8). It was in this upper lag unit that a kimberlitic fragment was

Figure 5. Kimberlitic clasts of various sizes collected from the esker in 2005. The clasts tend to be subrounded to rounded and fractures are common. The kimberlitic clasts are extremely susceptible to weathering, and one clast (fragments in sample bag) literally disintegrated when touched.

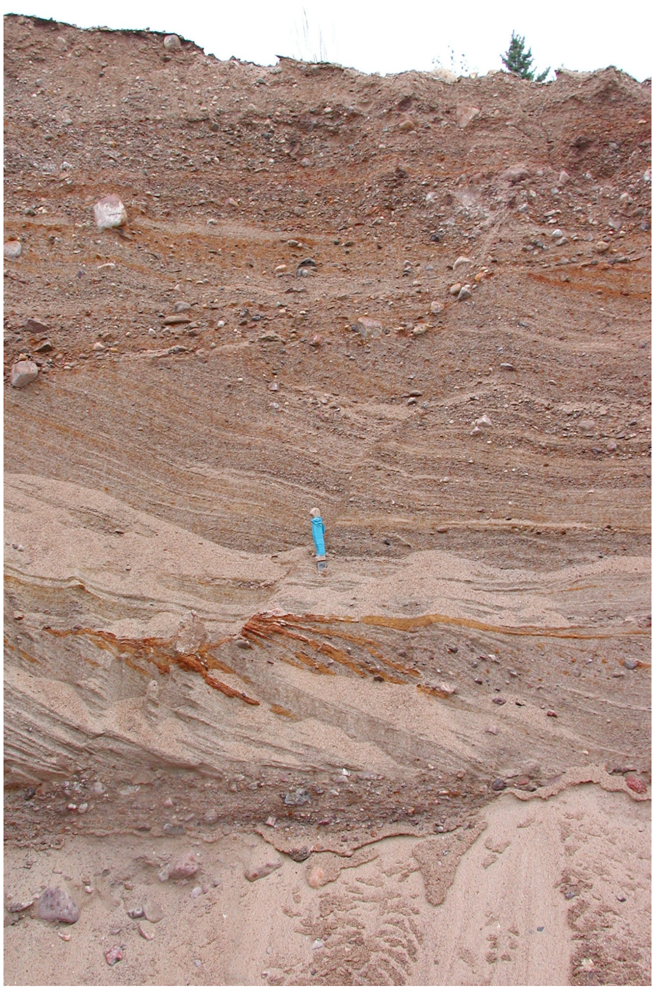

Figure 6. Quarrying in 2004 revealed an exposed face of section B (Fig. 10). The coarse upper unit is seen overlying a sandy unit. The largest clasts, including kimberlite, occur along the lower scoured contact of the crossbedded unit.

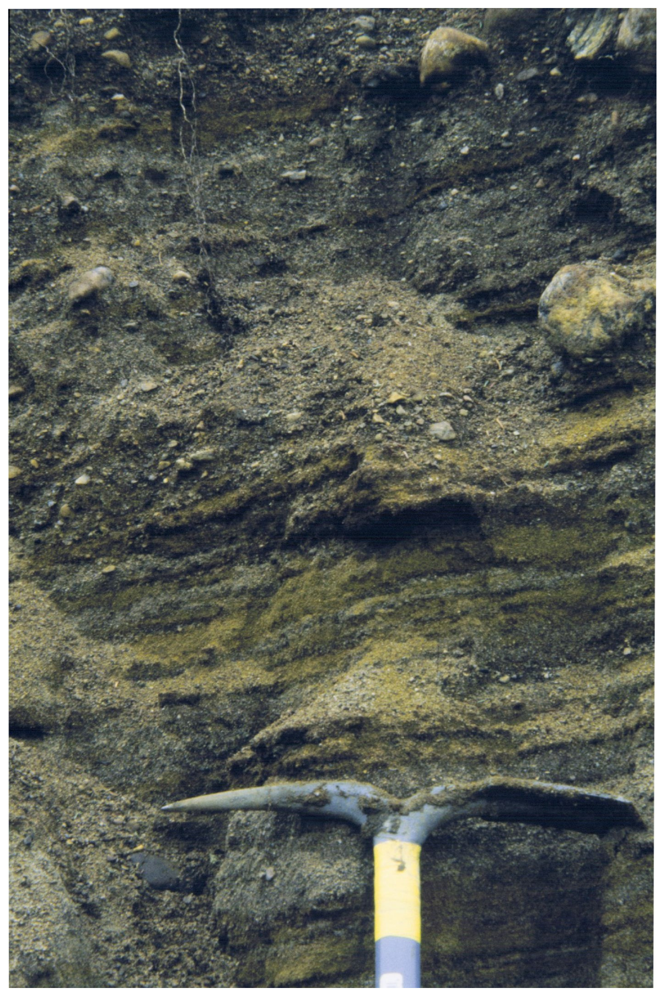

Figure 7. Planar beds of coarse gravel and granular sand are exposed in section A (Fig. 10). Below the head of the pick, coarse granular sands occur (yellow band on the pick is 10 cm). Photo courtesy of J. Pawlowicz (1998).

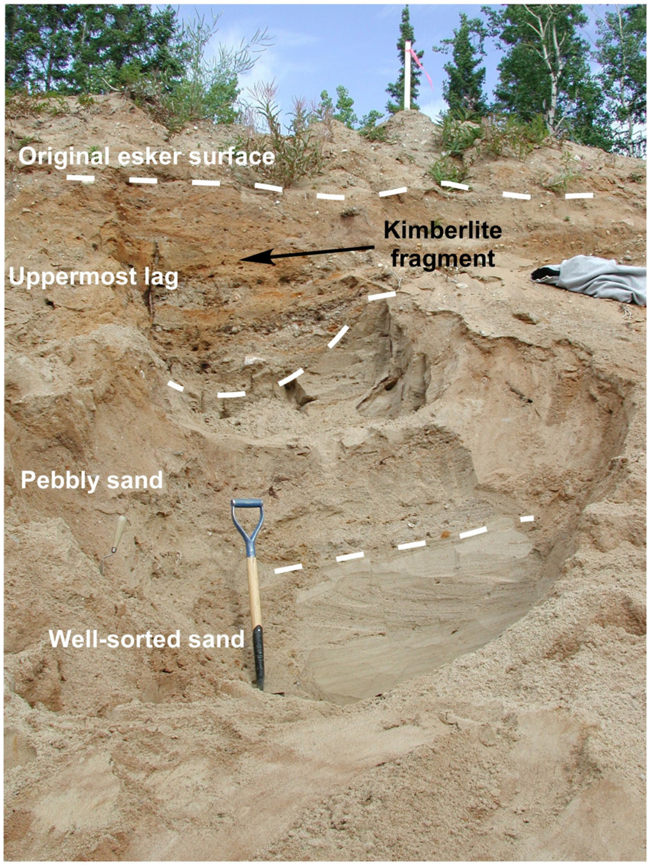

Figure 8. Upper portion of section B (Fig. 10). The coarse upper unit is seen overlying the well sorted sandy unit.

observed (Fig. 9). Overall, the beds dip southward and eastward, indicating paleoflow from the north (Fig. 10).

KIMBERLITE COBBLE

One kimberlite cobble (sample 03-MPB-009) was collected from the esker section for detailed mineralogical examination. It was collected from talus of the sand and gravel pit in 2003 and is the largest kimberlitic fragment obtained from repeated visits to this esker between 1997 and 2006. The cobble is well rounded and appears dark grey to brownish (Fig. 11A). It is heterogeneous and contains abundant subangular to rounded inclusions of crustal rock fragments in sizes up to 1 cm, as well as smaller rounded and altered inclusions with thin white coatings of carbonate. Dark, elongate shale fragments are the most obvious and easily recognizable inclusions.

Petrographic Description of Kimberlite Cobble 03-MPB-009

Microscopic examination of a thin section from the kimberlite cobble reveals a yellow-brown altered rock with abundant (>50%) highly altered rounded to subrounded lapilli rimmed by a very fine-grained brown matrix and calcite-filled interstices (Fig. 11B). Lapilli are 0.1 mm to >1 cm in diameter and consist of completely altered olivine pheno- or xenocrysts (thin-skinned olivine-cored lapilli, Fig. 11B), various country rock and kimberlite fragments, and other xenocrysts and xenoliths. Their original mineralogy is impossible to identify because they have been completely altered to serpentine, iddingsite, Fe-hydroxides, opaques, and carbonate. The very fine-grained light brown kimberlite groundmass contains tiny opaque grains (some of it being perovskite) as single grains and aggregates rimming lapilli, atoll spinel, and occasionally apatite, however, no phlogopite. This diatreme-facies kimberlite could be described as clast-supported to matrix-supported pyroclastic lapilli tuff.

METHODS

Sample Preparation

The kimberlite cobble was processed by Overburden Drilling Management Ltd. (ODM), Nepean, Ontario, to recover a heavy mineral concentrate for examination of kimberlite indicator minerals. Prior to processing, a small slice of kimberlite was taken off the cobble for archiving and petrographic description at the Geological Survey of Canada (GSC). Approximately 2 kg of the kimberlite cobble was crushed to <2.0 mm diameter fragments in a plate crusher and this material was then processed using a combination of tabling and heavy liquids (Fig. 12) to produce four size fractions of the non-ferromagnetic heavy mineral concentrate for indicator mineral picking: 0.18 to 0.25 mm, 0.25 to 0.5 mm, 0.5 to 1.0 mm, and 1.0 to 2.0 mm. Weights of sample material processed and fractions produced are listed in Appendix B. The 0.18 to 0.25 mm size fraction is not routinely picked for indicator minerals in kimberlite studies because this very fine-grained fraction is time consuming and, hence, expensive to pick. For this cobble sam-

Figure 9. Weathered fragment of kimberlite found in bedded sands in the upper portion of section B (Fig. 10).

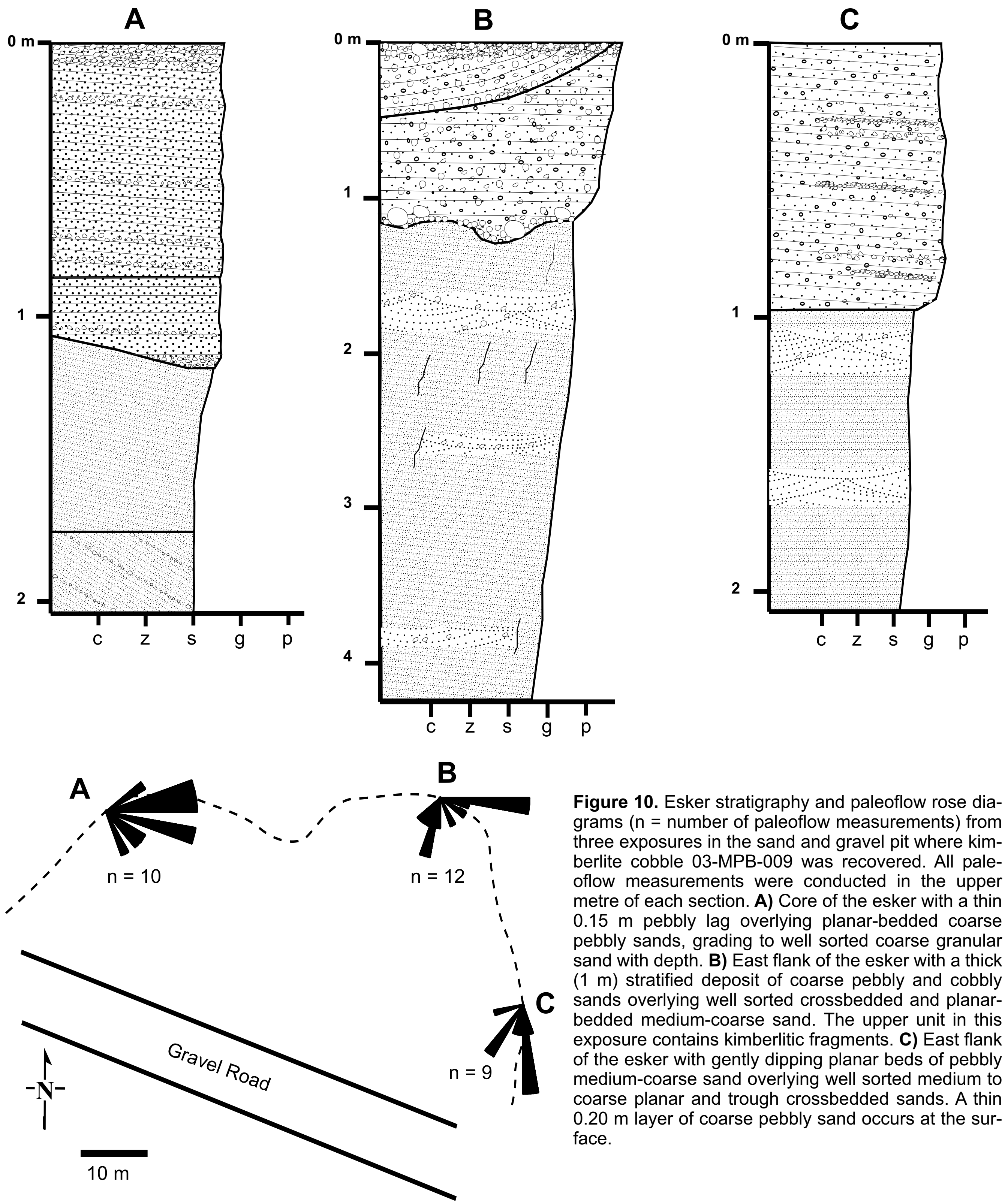

Figure 10. Esker stratigraphy and paleoflow rose diagrams (n = number of paleoflow measurements) from three exposures in the sand and gravel pit where kimberlite cobble 03-MPB-009 was recovered. All paleoflow measurements were conducted in the upper metre of each section. **A)** Core of the esker with a thin 0.15 m pebbly lag overlying planar-bedded coarse pebbly sands, grading to well sorted coarse granular sand with depth. **B)** East flank of the esker with a thick (1 m) stratified deposit of coarse pebbly and cobbly sands overlying well sorted crossbedded and planar-bedded medium-coarse sand. The upper unit in this exposure contains kimberlitic fragments. **C)** East flank of the esker with gently dipping planar beds of pebbly medium-coarse sand overlying well sorted medium to coarse planar and trough crossbedded sands. A thin 0.20 m layer of coarse pebbly sand occurs at the surface.

ple, however, the 0.18 to 0.25 mm fraction was picked for pyrope, eclogitic garnet, Cr-diopside, and Mg-ilmenite because of the low abundances of these four indicator mineral species in the three coarser size fractions. The 0.18 to 0.25 mm fraction was not examined for chromite or olivine. Grains were picked from this finer fraction for characterization of mineral compositions, not to determine mineral abundances in this finest fraction, thus counts for the 0.18 to 0.25 mm fraction have not been included in the normalization to 10 kg (Table 1).

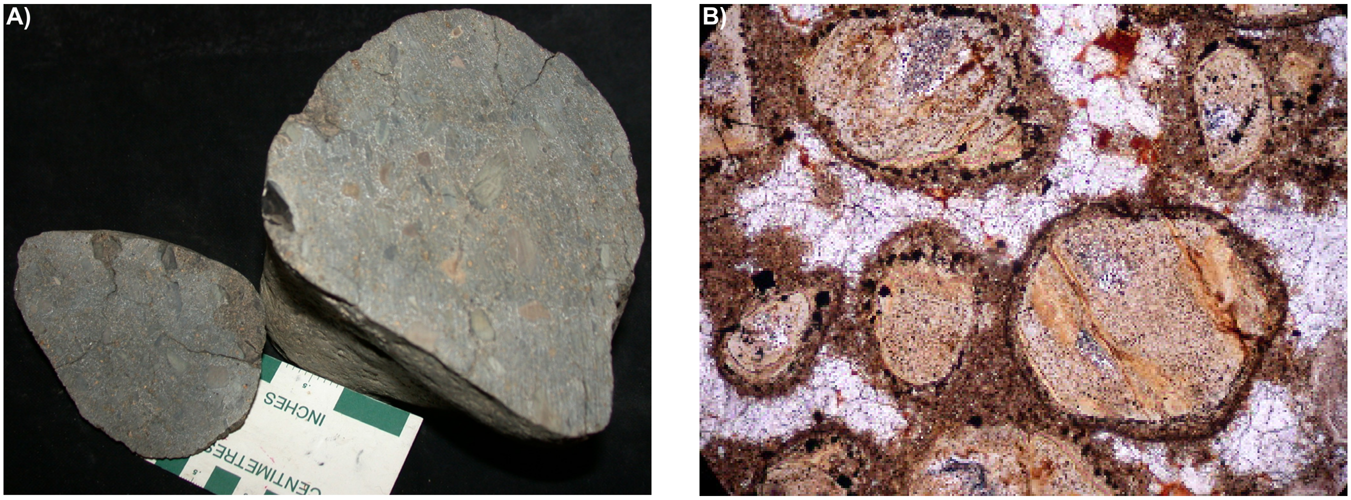

Figure 11. Photo of kimberlite cobble (sample 03-MPB-009) in hand specimen (A), and in thin section (B) showing thin-skinned olivine-cored lapilli (field of view of approximately 7 x 5 mm, transmitted light).

Kimberlite Indicator Mineral Identification

The four size fractions of the kimberlite cobble were examined by ODM using stereoscopic and petrographic microscopes and potential kimberlite indicator minerals were visually selected. Picking focused on purple Cr-pyrope, orange titanian pyrope, green Cr-diopside, black Mg-ilmenite and chromite, and pale yellow forsteritic olivine. These indicator minerals were identified on the basis of visual properties, such as colour, grain morphology, and the presence of adhering kimberlite matrix material (e.g. Table 1 in McClenaghan and Kjarsgaard, 2007). Picked grains were mounted in 25 mm epoxy mounts and polished at SGS Lakefield, Lakefield, Ontario in preparation for electron micro-

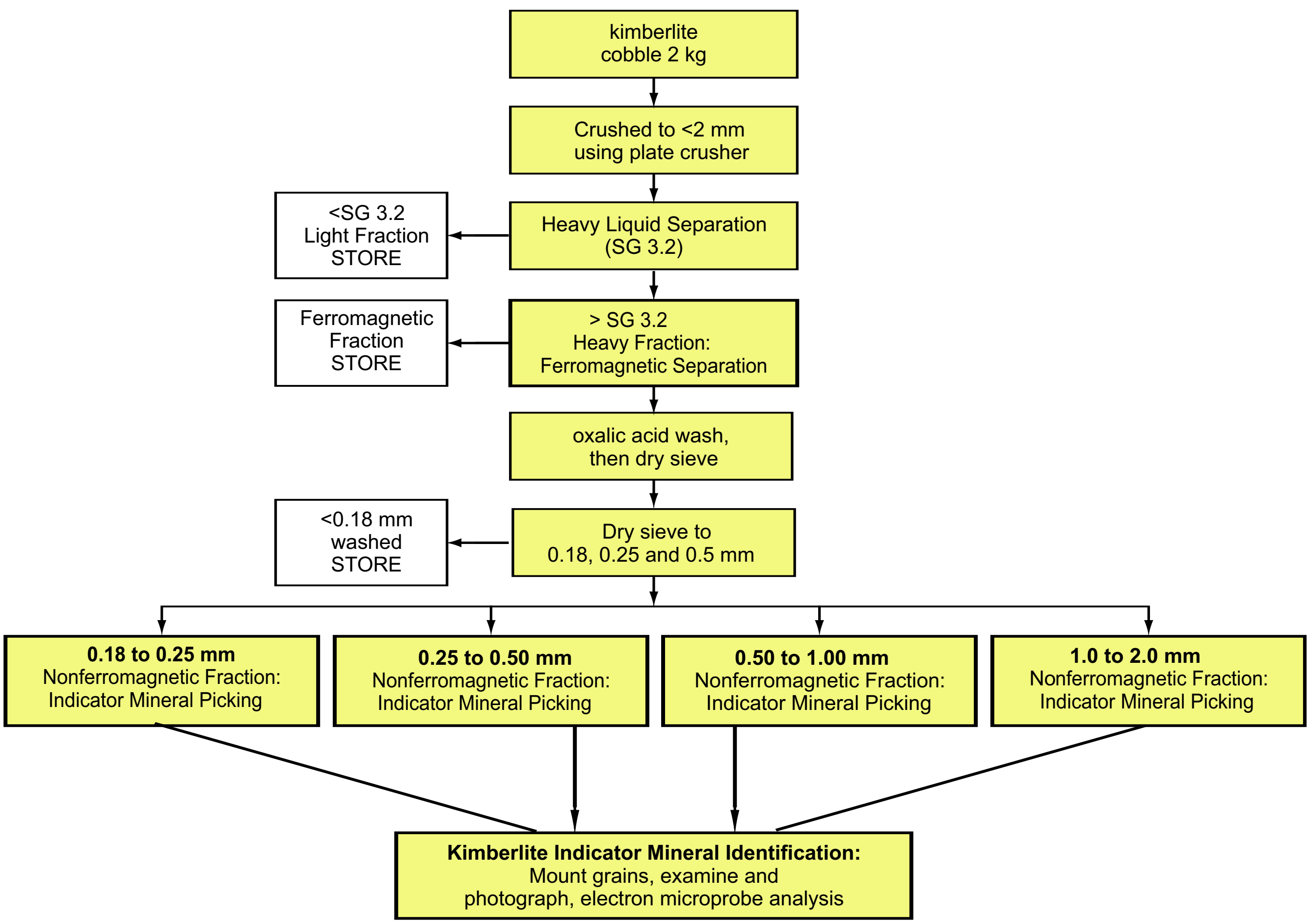

Figure 12. Flow diagram showing sample processing and picking procedures used for the kimberlite cobble (sample 03-MPB-009).

Table 1. Abundance of indicator minerals in the 0.18 to 0.25, 0.25 to 0.5, 0.5 to 1.0, and 1.0 to 2.0 mm fractions of the K4 esker cobble determined by visual counting and microprobe analysis, and the counts standardized to 10 kg sample weights.

A) Number of grains visually identified as indicator minerals.

Sample Number	1.0 to 2.0 mm						0.5 to 1.0 mm						0.25 to 0.5 mm						0.18 to 0.25 mm					
	Cr-Pyrope 1-2 mm	E-garnet 1-2 mm	Cr-diopside 1-2 mm	Mg-ilmenite 1-2 mm	chromite 1-2 mm	forsteritic olivine 1-2 mm	Cr-Pyrope 0.5-1 mm	E-garnet 0.5-1 mm	Cr-diopside 0.5-1 mm	Mg-ilmenite 0.5-1 mm	chromite 0.5-1 mm	forsteritic olivine 0.5-1 mm	Cr-Pyrope 0.25-0.5 mm	E-garnet 0.25-0.5 mm	Cr-diopside 0.25-0.5 mm	Mg-ilmenite 0.25-0.5 mm	chromite 0.25-0.5 mm	forsteritic olivine 0.25-0.5 mm	Cr-Pyrope 0.18-0.25 mm	E-garnet 0.18-0.25 mm	Cr-diopside 0.18-0.25 mm	Mg-ilmenite 0.18-0.25 mm	chromite 0.18-0.25 mm	forsteritic olivine 0.18-0.25 mm
03-MPB-009	0	0	0	0	1	4	1	0	1	0	62	98	23	39	9	0	278	369	28	67	15	0	not picked	not picked

B) Number of grains probed

Sample Number	1.0 to 2.0 mm						0.5 to 1.0 mm						0.25 to 0.5 mm						0.18 to 0.25 mm					
	Cr-Pyrope 1-2 mm	E-garnet 1-2 mm	Cr-diopside 1-2 mm	Mg-ilmenite 1-2 mm	chromite 1-2 mm	forsteritic olivine 1-2 mm	Cr-Pyrope 0.5-1 mm	E-garnet 0.5-1 mm	Cr-diopside 0.5-1 mm	Mg-ilmenite 0.5-1 mm	chromite 0.5-1 mm	forsteritic olivine 0.5-1 mm	Cr-Pyrope 0.25-0.5 mm	E-garnet 0.25-0.5 mm	Cr-diopside 0.25-0.5 mm	Mg-ilmenite 0.25-0.5 mm	chromite 0.25-0.5 mm	forsteritic olivine 0.25-0.5 mm	Cr-Pyrope 0.18-0.25 mm	E-garnet 0.18-0.25 mm	Cr-diopside 0.18-0.25 mm	Mg-ilmenite 0.18-0.25 mm	chromite 0.18-0.25 mm	forsteritic olivine 0.18-0.25 mm
03-MPB-009	0	0	0	0	0	0	0	0	0	0	0	0	23	39	9	0	98	92	29	66	14	0	not picked	not picked

C) Number of grains confirmed to be indicator minerals by probe analysis

Sample Number	1.0 to 2.0 mm						0.5 to 1.0 mm						0.25 to 0.5 mm						0.18 to 0.25 mm					
	Cr-Pyrope 1-2 mm	E-garnet 1-2 mm	Cr-diopside 1-2 mm	Mg-ilmenite 1-2 mm	chromite 1-2 mm	forsteritic olivine 1-2 mm	Cr-Pyrope 0.5-1 mm	E-garnet 0.5-1 mm	Cr-diopside 0.5-1 mm	Mg-ilmenite 0.5-1 mm	chromite 0.5-1 mm	forsteritic olivine 0.5-1 mm	Cr-Pyrope 0.25-0.5 mm	E-garnet 0.25-0.5 mm	Cr-diopside 0.25-0.5 mm	Mg-ilmenite 0.25-0.5 mm	chromite 0.25-0.5 mm	forsteritic olivine 0.25-0.5 mm	Cr-Pyrope 0.18-0.25 mm	E-garnet 0.18-0.25 mm	Cr-diopside 0.18-0.25 mm	Mg-ilmenite 0.18-0.25 mm	chromite 0.18-0.25 mm	forsteritic olivine 0.18-0.25 mm
03-MPB-009	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	14	1	9	0	93	92	24	0	14	0	not picked	not picked
	N/A = not analyzed											% correct	61%	3%	100%		95%	100%	83%	0%	100%			

D) Number of grains visually identified (A) but not analyzed multiplied by the percentage correctly identified in (C)

Sample Number	1.0 to 2.0 mm						0.5 to 1.0 mm						0.25 to 0.5 mm						0.18 to 0.25 mm					
	Cr-Pyrope 1-2 mm	E-garnet 1-2 mm	Cr-diopside 1-2 mm	Mg-ilmenite 1-2 mm	chromite 1-2 mm	forsteritic olivine 1-2 mm	Cr-Pyrope 0.5-1 mm	E-garnet 0.5-1 mm	Cr-diopside 0.5-1 mm	Mg-ilmenite 0.5-1 mm	chromite 0.5-1 mm	forsteritic olivine 0.5-1 mm	Cr-Pyrope 0.25-0.5 mm	E-garnet 0.25-0.5 mm	Cr-diopside 0.25-0.5 mm	Mg-ilmenite 0.25-0.5 mm	chromite 0.25-0.5 mm	forsteritic olivine 0.25-0.5 mm	Cr-Pyrope 0.18-0.25 mm	E-garnet 0.18-0.25 mm	Cr-diopside 0.18-0.25 mm	Mg-ilmenite 0.18-0.25 mm	chromite 0.18-0.25 mm	forsteritic olivine 0.18-0.25 mm
03-MPB-009	0	0	0	0	1	4	1	0	1	0	59	98	14	1	9	0	264	369	24	0	15	0	not picked	not picked

E) Number of grains (D) normalized to 10 kg sample weight

Sample Number	1.0 to 2.0 mm						0.5 to 1.0 mm						0.25 to 0.5 mm						0.18 to 0.25 mm					
	Cr-Pyrope 1-2 mm	E-garnet 1-2 mm	Cr-diopside 1-2 mm	Mg-ilmenite 1-2 mm	chromite 1-2 mm	forsteritic olivine 1-2 mm	Cr-Pyrope 0.5-1 mm	E-garnet 0.5-1 mm	Cr-diopside 0.5-1 mm	Mg-ilmenite 0.5-1 mm	chromite 0.5-1 mm	forsteritic olivine 0.5-1 mm	Cr-Pyrope 0.25-0.5 mm	E-garnet 0.25-0.5 mm	Cr-diopside 0.25-0.5 mm	Mg-ilmenite 0.25-0.5 mm	chromite 0.25-0.5 mm	forsteritic olivine 0.25-0.5 mm	Cr-Pyrope 0.18-0.25 mm	E-garnet 0.18-0.25 mm	Cr-diopside 0.18-0.25 mm	Mg-ilmenite 0.18-0.25 mm	chromite 0.18-0.25 mm	forsteritic olivine 0.18-0.25 mm
03-MPB-009	0	0	0	0	5	21	5	0	5	0	303	503	72	1	46	0	1354	1892	123	0	77	0	not picked	not picked

Sample weight 1.95 kg

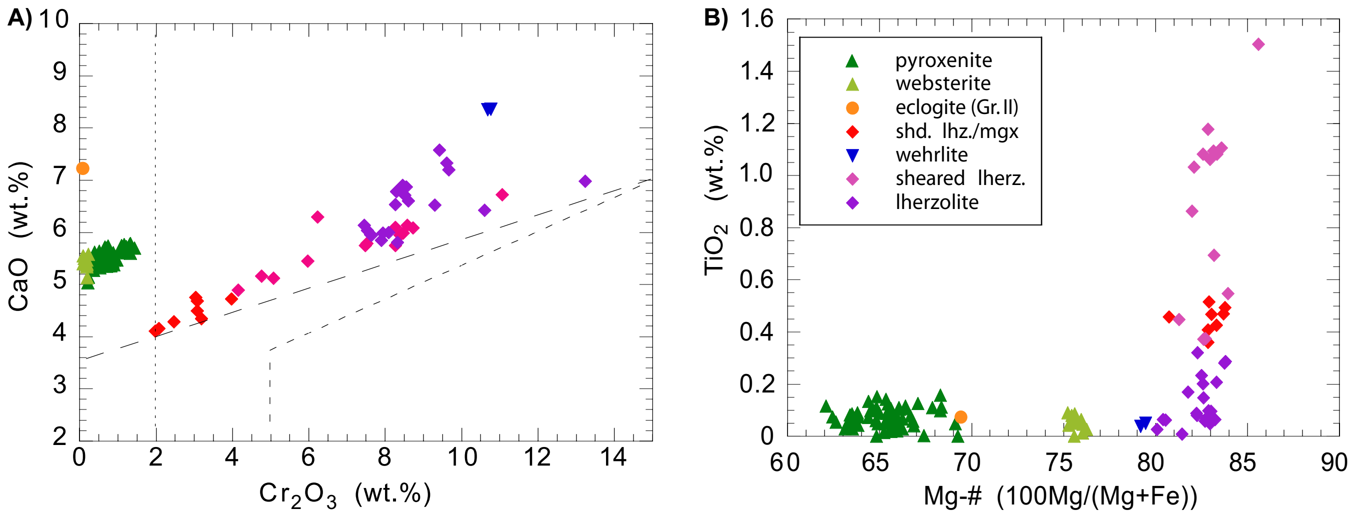

Figure 13. A) CaO versus Cr_2O_3 plot for pyrope garnet from the kimberlite cobble (sample 03-MPB-009) using the classification scheme of Grütter et al. (2004). Diagonal dashed line is the 85% line of Gurney (1984) separating lherzolitic G9 from subcalcic G10 garnets. Field in lower right corner is the field of subcalcic diamond inclusion garnets according to Sobolev (1977). **B)** TiO_2 versus Mg-# plot for low Cr- and high Ti-garnets (low Ti-lherzolitic garnets are not shown).

probe analysis to confirm their identity and further classify them using mineral chemistry. Electron microprobe analyses were carried out at the GSC, Ottawa, using operating conditions and mineral sorting routines similar to those described by McClenaghan et al. (1999). Microprobe analyses for those minerals identified as kimberlite indicator minerals are listed in Appendix C and the number of each indicator mineral species analyzed in the cobble are reported in Table 1. Visual counts reported for 'Cr-pyrope' are the sum of Cr-pyrope and pyrope grains. Cr-diopside is defined as diopside containing >0.5 wt.% Cr_2O_3. Garnets are subdivided into the following classes: G1 (megacryst), G3 (eclogite), G4 (websterite / pyroxenite), G9 (lherzolite), G10 (harzburgite), G11 (sheared lherzolite), and G12 (wehrlite) according to Grütter et al. (2004). Visual ('picked') indicator mineral counts in Table 1A were revised to reflect the number of grains confirmed to be indicator minerals by microprobe analysis and these revised values were then standardized to a 10 kg sample weight.

INDICATOR MINERAL ABUNDANCES

The kimberlite cobble contains a few 1000 grains per 10 kg (Table 1). The most abundant indicator minerals by far in the cobble are forsteritic olivine and chromite, accompanied by minor amounts of pyrope and Cr-diopside, and one eclogitic (Group II) garnet. The cobble contains no Mg-ilmenite (Table 1). Of the three size fractions systematically examined, indicator minerals are most abundant in the 0.25 to 0.5 mm fraction.

INDICATOR MINERAL CHEMISTRY

Of the 372 grains analyzed from the 0.18 to 2.0 mm heavy mineral fraction of cobble sample 03-MPB-009, 92 were olivine, 87 chromite or Cr-spinels, 70 pyropes, 44 Cr-pyrope (>2 wt.% Cr_2O_3), 24 crustal almandine (>22 wt.% FeO_{tot}), 13 pink corundum, 7 other spinels (hercynite and Cr-Al-magnetite), two calcite, one zircon, one andradite-grossular, one ilmenite (low Mg), and two non-stoichiometric FeTi oxide mixtures. The compositional characteristics of the kimberlite indicator minerals chromite, Mg-ilmenite, pyrope garnet, Cr-diopside, as well as olivine, corundum, and spinel are discussed below. The other grains were analyzed because they resembled the above kimberlite indicator minerals but will not be further discussed here.

Compositional Characteristics of Kimberlite Indicator Minerals

Mg-ilmenite

A single ilmenite grain recovered from this cobble has a low MgO content (<4 wt.%) and is likely of crustal origin. No Mg-rich kimberlitic ilmenite was recovered.

Garnet

Recovered pyrope grains can be divided into three major groups: purple Cr-pyrope (>2 wt.% Cr_2O_3), orange to red pyrope (Fig. 13) and crustal (Mn-) almandine (>22 wt.% FeO_{tot}), the latter will not be further discussed here. Cr-pyrope compositions plot above as well as follow Gurney's (1984) 85% line (Fig. 13A), i.e., they are from fertile lherzolitic to harzburgitic mantle xenoliths. The highest Cr_2O_3 value is 13.4 wt.%, but there are no subcalcic (G10) Cr-pyropes in this cobble. Several of the Cr-pyrope grains contain elevated TiO_2 (0.7-1.5 wt.%, Fig. 13B) at medium to high Cr_2O_3 contents indicating that they are from metasomatized (sheared) lherzolites (Dawson and Stephens, 1975; Grütter et al., 2004). A few Ti-rich Cr-pyrope grains (<4 wt.% Cr_2O_3), classified as megacrysts following the nomenclature of Grütter et al. (2004), could also be added to the sheared lherzolite group since they contain comparatively high Cr_2O_3 (>2 wt.%), do not plot as a tight compositional cluster as megacryst garnets commonly do, and seem to grade into the group of sheared lherzolitic garnets. The highest TiO_2 contents are found in the more Cr-rich pyrope (Fig. 13B). Ti-poor lherzolitic/harzburgitic Cr-pyropes plot towards higher CaO with increasing Cr_2O_3, deviating from the 85% line (Fig. 13A). Two particularly Ca- and Cr-rich grains were classified as wehrlitic garnets (Fig. 13A).

With the exception of one Ca-rich eclogitic garnet, the orange low-Cr pyropes plot in a narrow compositional field between 5.0 and 5.7 wt.% CaO and 0 to 1.5 wt.% Cr_2O_3 in Figure 13A. The tight compositional clustering of these grains suggests that they were derived from a few larger crushed or disaggregated grains as is commonly the case for megacryst garnets. However, they display low TiO_2 (<0.5 wt.%) and fairly high FeO_{tot} (13-15 wt.%) contents and form two separate groups in terms of Mg-# (Fig. 13B). The larger group has Mg-#s of 62 to 70 and is most likely from garnet-pyroxenites, the other (smaller) group has Mg-#s from 75 to 76 and could be from garnet-bearing websterite. One orange pyrope contains distinctly higher CaO (>7 wt.%) and very low Cr_2O_3 compared to the pyroxenitic garnets (Fig. 13A). With low Ti and low Na values, it is most likely from a Group II (i.e. non-diamondiferous) eclogite according to the classification of McCandless and Gurney (1989).

Spinel

Cr-rich spinel is the second most abundant indicator mineral found in this cobble. Several populations of spinel can be recognized: chromite *sensu strictu* (i.e. Cr-spinel with molecular $Cr_2O_3 > Al_2O_3$) is represented by 30 grains. Their compositions scatter widely between 37.2 and 64.7 wt.% Cr_2O_3 and up to 15 wt.% Al_2O_3, with three of them plotting in the diamond inclusion field (Fig. 14). Their composition is typical of chromite found in garnet-peridotitic xenoliths from kimberlites (e.g. Meyer et al., 1994; Schulze, 1996; Vicker, 1997). A group of Cr-spinel grains containing between 25 and 35 wt.% Cr_2O_3 plots as a narrow cluster around 15 wt.% MgO; these are most likely from spinel-lherzolite xenoliths. A second population of low-Cr spinels contains between 11.8 and 17 wt.% Cr_2O_3; these might be from crustal ultramafic rocks. Several hercynite (Mg,Fe-Al-spinel) and Cr- and Al-rich magnetite grains were found in the cobble. Hercynite occurs in association with corundum in the Buffalo Head Hills kimberlites (Hood and McCandless, 2004) and there are no other bedrock

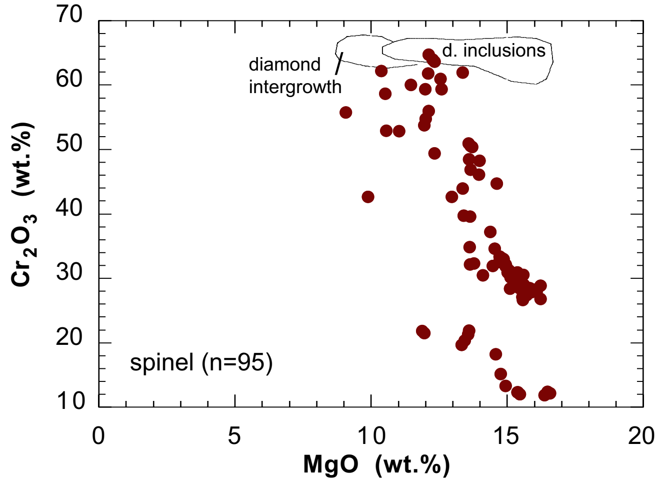

Figure 14. Cr_2O_3 versus MgO plot for Cr-bearing spinel from the kimberlite cobble (sample 03-MPB-009). Fields for diamond intergrowth and diamond inclusion chromites are from Fipke et al. (1995).

sources for this mineral in the area. Three grains of Cr-Al-rich magnetite were found that might also belong to these assemblages.

Cr-diopside

A total of 23 Cr-diopside grains were analyzed from the cobble and range in Mg-# from 88 to 93.5 and in Cr_2O_3 content from 0.5 to 2.2 wt.% (Fig. 15A). Four of these grains contain significantly higher Al_2O_3 (4.95-5.76 wt.%) than the rest (which contain <2 wt.% Al_2O_3) and display the lowest Mg-#s (88 to 91) but similar Na_2O and Cr_2O_3 as the bulk of the Cr-diopsides. These four grains plot in the field of spinel-lherzolite (SL, Fig. 15B), whereas the other 19 Cr-diopside grains plot in the field of garnet-lherzolite (GP, Fig. 15B) according to Nimis (1998).

Olivine

A total of 92 olivine grains were analyzed from the cobble. The grains have Fo contents between 88.5 and 93.5 and NiO contents between 0.25 and >0.5 wt.% (Fig. 16). They plot as a compositionally homogeneous group in Figure 16 in the area typically occupied by peridotitic mantle olivine or kimberlitic megacryst olivine.

Chromian corundum (ruby)

Thirteen grains of pink corundum were analyzed because they had been picked as pyrope garnets. The grains contain high levels of Cr_2O_3 (3.2-6.7 wt.%) (Fig. 17), which is significantly higher than the Cr content of metamorphic rubies (Hutchinson et al., 2004). They are very similar in composition to gem-quality rubies found in the Tandem kimberlite from the Kirkland Lake kimberlite field, northeast Ontario (Sage, 2000)

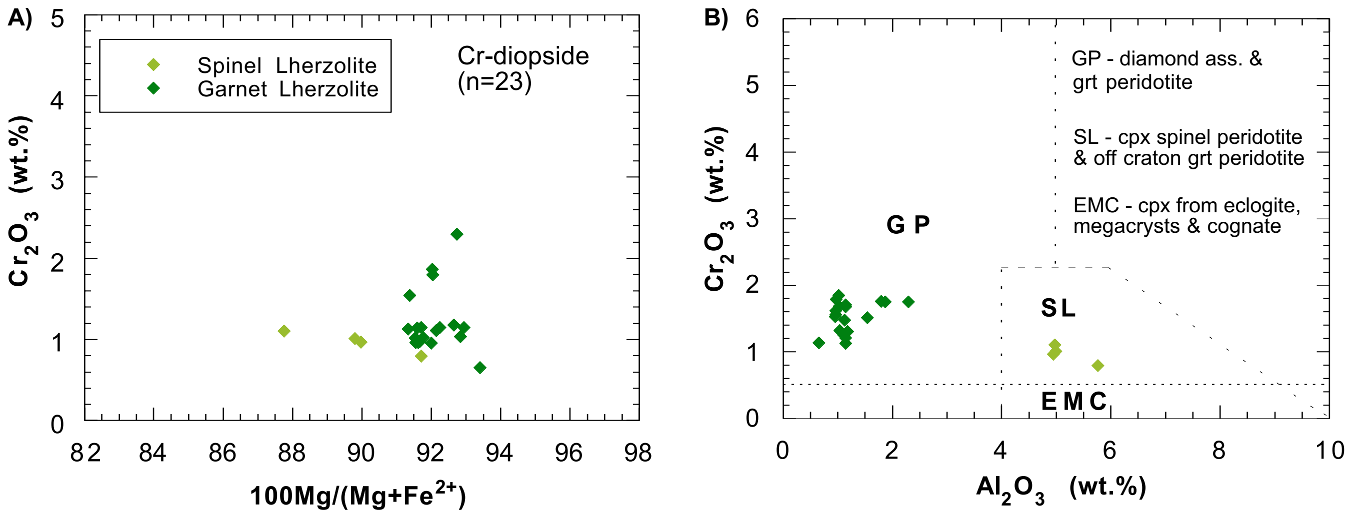

Figure 15. Cr_2O_3 versus Mg# plot **(A)** and Cr_2O_3 versus Al_2O_3 plot **(B)** for Cr-diopside from the kimberlite cobble (sample 03-MPB-009). Fields in plot (B) are from Nimis (1998).

DISCUSSION

The kimberlite cobble studied here is characterized by a low indicator mineral content with 100s to 1000s of grains per 10 kg, most of them in the 0.25 to 0.5 mm fraction.

Olivine and chromite are the most abundant indicator minerals, while Cr-pyrope and Cr-diopside are less common. Only one Group II orange eclogitic garnet grain was found in the cobble and Mg-ilmenite is absent.

Mg-ilmenite

Mg-ilmenite was not recovered from the kimberlite cobble. This absence is not unexpected because Mg-ilmenite is scarce in the Buffalo Head Hills kimberlites and was only recovered in trace to minor amounts from a few kimberlites (Eccles et al., 2004; Hood and McCandless, 2004).

Garnet

The garnet compositions reported here are similar to those reported by Eccles et al. (2004) and Hood and McCandless (2004) for various Buffalo Head Hills kimberlites. The salient features of the garnet compositions of the kimberlite cobble and for the Buffalo Head Hills kimberlites in general are 1) peridotitic garnets that follow the lherzolite trend to high Cr_2O_3 (up to 18 wt.%), but rarely plot below the 85% line into the field of subcalcic garnets; and 2) trend towards Ca-rich and Cr-rich wehrlitic compositions. Eccles et al. (2004) and Hood and McCandless (2004) also report the presence

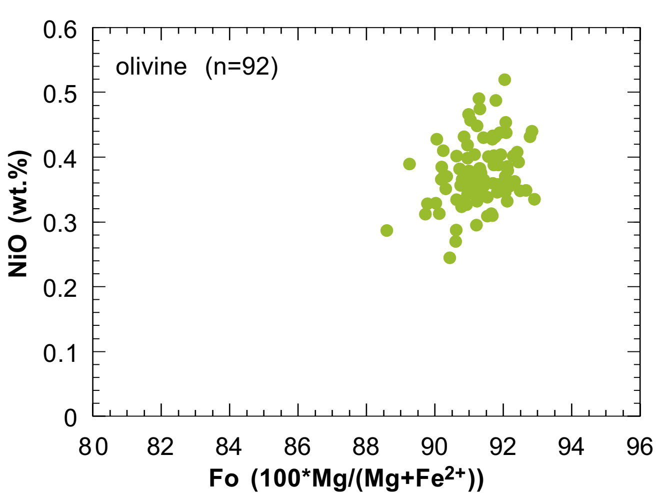

Figure 16. NiO versus Fo (Mg-#) for olivine from the kimberlite cobble (sample 03-MPB-009).

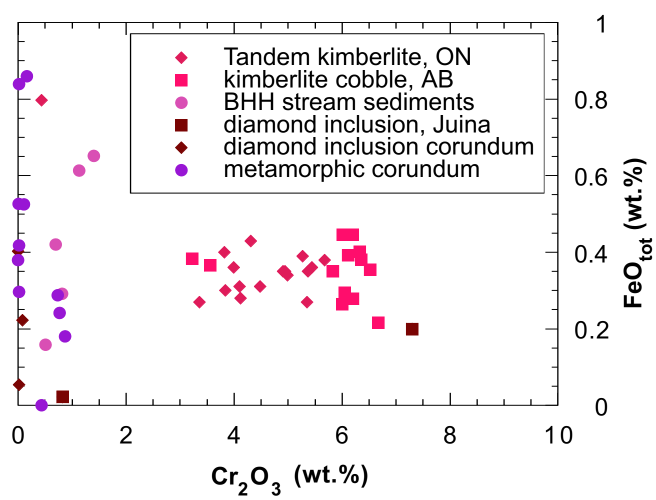

Figure 17. FeO_{tot} versus Cr_2O_3 for corundum from the kimberlite cobble (sample 03-MPB-009), the Tandem kimberlite (Sage, 2000), stream sediments in the Buffalo Head Hills (Friske et al., 2003), diamond inclusions (DI), and metamorphic rocks (Hutchinson et al., 2004).

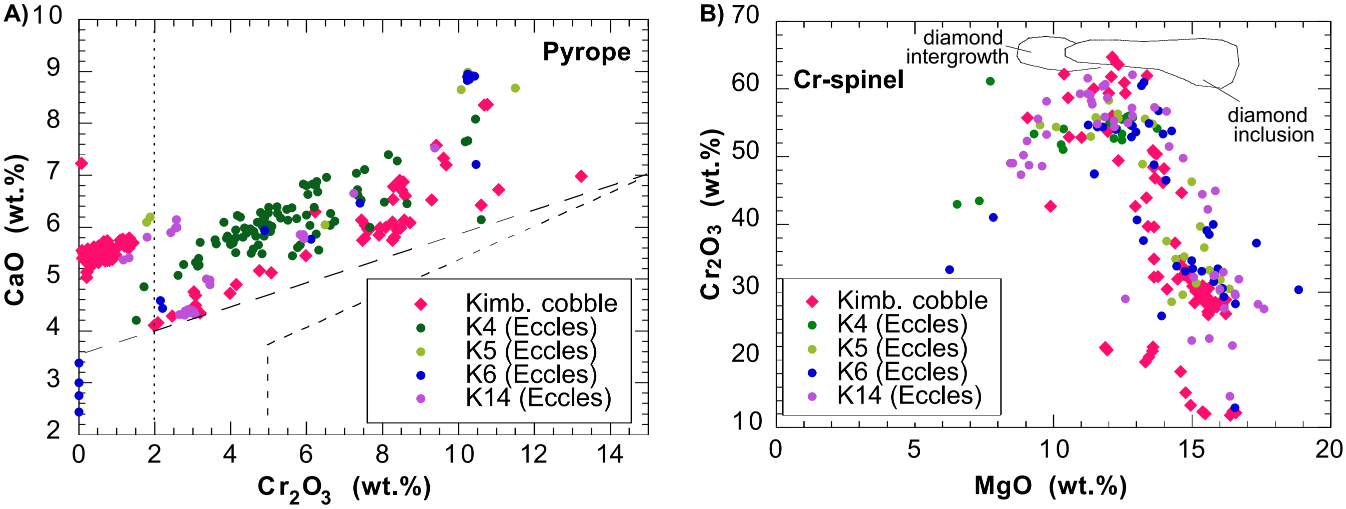

Figure 18. Comparison of published data for the K4, K5, K6, and K14 kimberlites (Eccles et al., 2004), which are situated north (up-flow) of the cobble sample site, with those of the kimberlite cobble (sample 03-MPB-009). **A)** CaO versus Cr_2O_3 plot for pyrope garnet (fields defined in Fig. 13). **B)** Cr_2O_3 versus MgO plot for Cr-bearing spinel (fields for diamond intergrowth and diamond inclusion chromites are from Fipke et al., 1995).

of minor amounts of eclogitic garnet, although they do not specify whether they are from Group I (potentially diamondiferous) or Group II (not diamond-bearing) eclogite. Interestingly, a suite of diamond inclusion minerals from Buffalo Head Hills kimberlites studied by Davies et al. (2004) contains predominantly eclogitic minerals with minor contributions from garnet-websterite and harzburgite. Pyroxenitic garnet compositions with low Cr content and low Mg-#s identical to those found in the cobble were also reported by Aulbach et al. (2004) from garnet-pyroxenite xenoliths from the K14 kimberlite (Fig.18A). Comparison of the cobble data with available garnet data for the K4, K5, K6, and K14 kimberlites (Eccles et al., 2004), located north (up-ice) of the cobble sample site, reveal that the most similar garnet compositions are those of the K14 kimberlite (Fig. 18A). However, the K14 kimberlite lacks the more Cr-rich lherzolitic garnets found in the cobble. Figure 18A also shows that the composition of garnets from the K4, K5, and K6 kimberlites do not overlap much with those of the cobble, which makes these kimberlites unlikely sources for the kimberlite cobble.

Chromite

The abundance of chromite/Cr-spinel in this cobble is in agreement with the finding that chromite is the most abundant indicator mineral in kimberlites of the area (Hood and McCandless, 2004). The compositional variation of the chromite, and particularly the abundance of less Cr-rich Cr-spinels in the cobble, most closely resemble that of the 'Northern Group' of Buffalo Head Hills kimberlites (including the K10 and K11 kimberlite) described by Hood and McCandless (2004). Diamond inclusion chromites were also reported from the K4 kimberlite (Eccles et al., 2004) and other kimberlites of the Southern Group (Hood and McCandless, 2004). A comparison of chromite data from kimberlites K4, K5, K6, and K14 (Eccles et al., 2004) with those from the cobble show that chromites from K4 overlap the least with those from the cobble whereas the chromite and Cr-spinel populations of the K6 and K14 and to a lesser extent the K5 kimberlites occupy approximately the same range in the Cr_2O_3 versus MgO diagram (Fig. 18B). Hood and McCandless (2004) also report the occurrence of Cr-poor hercynite that is associated with corundum in the Buffalo Head Hills kimberlites and is unrelated to the occurrence of diamond.

Cr-diopside

Several studies confirm the presence of both garnet-lherzolitic and spinel-lherzolitic diopside in the Buffalo Head Hills kimberlites (Aulbach et al., 2004; Eccles et al., 2004; Hood and McCandless, 2004), which were also found in the cobble studied here.

Olivine

Fresh olivine is common in Buffalo Head Hills kimberlites and most published compositions are similar to the range reported here, i.e., that of kimberlitic megacryst or peridotitic olivine (Aulbach et al., 2004; Eccles et al., 2004; Hood and McCandless, 2004). Till and especially stream sediment samples are olivine-rich in the vicinity of the northern olivine-rich kimberlites, such as K5, K6, and K14 (Fig. 19), and olivine-poor around kimberlites located west and south (e.g. K4 bodies) (Friske et al., 2003; Prior et al., 2005). This pattern suggests that the abundant olivine in surficial sediments is derived from the olivine-rich kimberlites to the north. Thus, it is likely that the olivine-rich kimberlite cobble from the esker is also derived from these northern kimberlites.

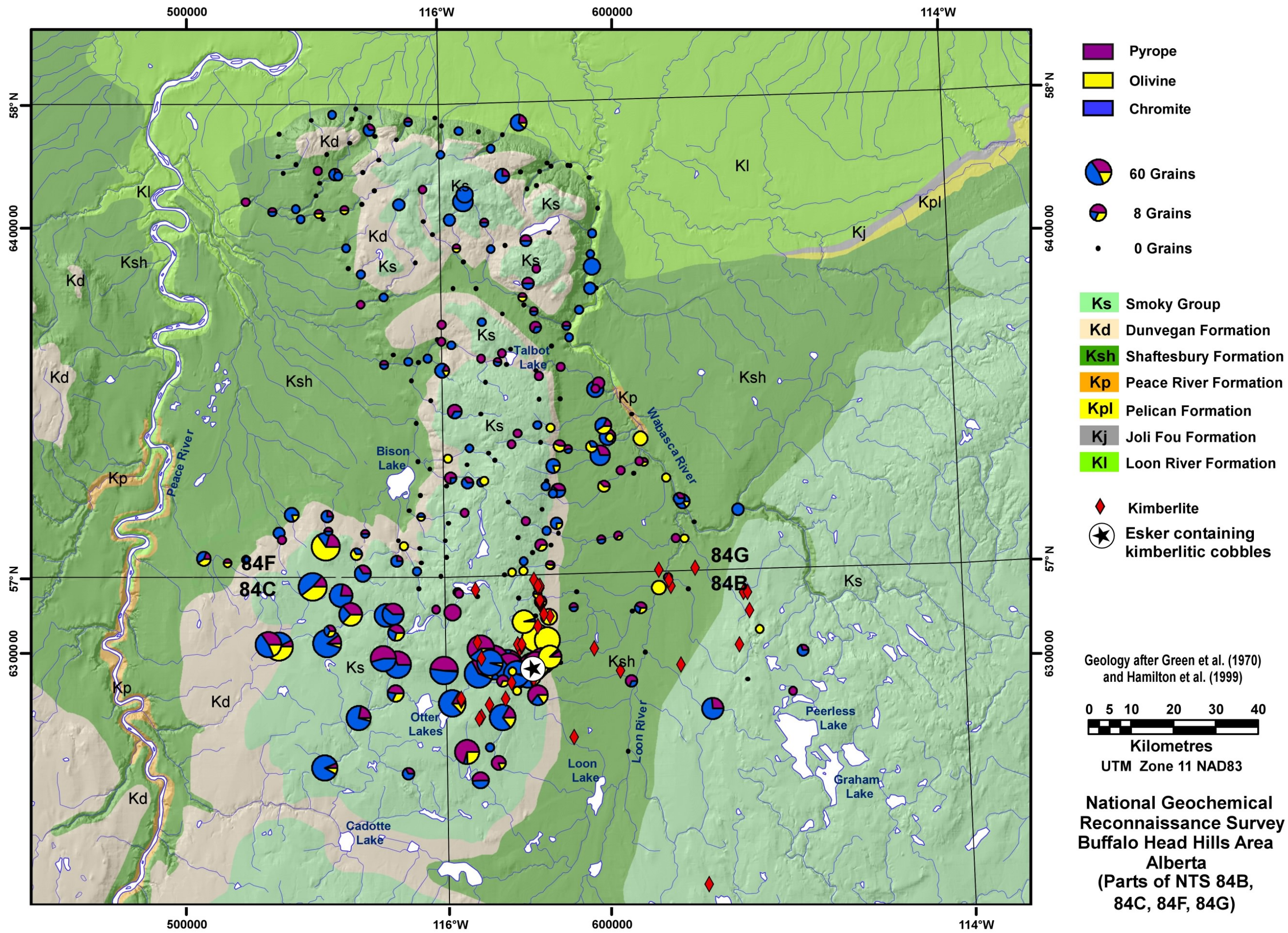

Figure 19. Distribution of pyrope, olivine, and chromite in the 0.25 to 2.0 mm picked fractions of stream sediment in the Buffalo Head Hills area, north-central Alberta (from Prior et al., in press). Note counts are not normalized.

Chromian corundum

Chromian corundum is present the northern kimberlites (north of K5) in the Buffalo Head Hills (Hood and McCandless, 2004). Because of the absence of corundum-bearing bedrock in the region, corundum can be used as a kimberlite indicator mineral in the Buffalo Head Hills. The pink corundum found in the northern Buffalo Head Hills kimberlites and in the kimberlite cobble have Cr_2O_3 contents that are several orders of magnitude above those of rubies from metamorphic rocks (Hutchinson et al., 2004) but very similar to strongly coloured rubies that occur as inclusions in diamonds from Juina, Brazil (Hutchinson et al., 2004) and gem-quality rubies from the Tandem kimberlite in the Kirkland Lake field, northeast Ontario (Sage, 2000) (Fig. 17). The presence of chromian corundum in Buffalo Head Hills kimberlites is unrelated to the presence of diamond but is linked to the presence of Mg-Al spinel in the kimberlites (Hood and McCandless, 2004). The presence of Mg-Al spinel in the kimberlites is thought to be due to Al-rich mantle assemblages incorporated as xenoliths similar to those reported by Mazzone and Haggerty (1989) from Jagersfontein, South Africa.

In summary, the indicator mineral abundances and compositions of the kimberlite cobble studied here suggest derivation from fertile (i.e. not Ca-depleted) garnet- and spinel-lherzolite, as well as minor amounts of Al-rich hercynite and corundum-bearing assemblages and rare non-diamondiferous eclogite. Comparison with available data for the K4, K5, K6, and K14 kimberlites (Eccles et al., 2004), located north of the cobble sample site, show that the garnet and spinel compositions of the K4 kimberlite are not very similar to those of the cobble (Fig. 18), which makes the K4 kimberlite an unlikely source. Chromite compositions of K5 and K6 kimberlites, however, are quite similar to those of the boulder, and garnet data for those kimberlites, although not very numerous, also show limited overlap with those of the cobble (Fig. 18A). Garnet from the K14 kimberlite (which are more numerous) show better compositional overlap with those of the cobble but chromite data for the K14 kimberlite are less similar to those of the cobble than those of the K5 and K6 kimberlites. Considering that the indicator minerals recovered from this cobble are predominantly from mantle xenoliths, their compositions will not be unique to a specific kimberlite. Several closely spaced pipes can easily have sampled the same mantle material. Thus, it can tentatively be concluded that the kimberlite cobble is probably derived from kimberlites further north of the sample site (e.g. kimberlites K6 or K14) but not from the most adjacent kimberlite(s) (K4). However, we do not have sufficient data to compare the boulder to every kimberlite in its vicinity and up-ice/up-stream.

SUMMARY AND CONCLUSIONS

The indicator mineral abundances and compositions found in cobble 03-MPB-009 are similar to indicator mineral data published for the Buffalo Head Hills kimberlites, particularly the defined group of northern kimberlites (Aulbach et al., 2004; Hood and McCandless, 2004; Eccles et al., 2004). Olivine and chromite are by far the most abundant indicator minerals in the cobble and in the kimberlites, whereas Cr-pyrope and Cr-diopside occur only in minor amounts and Mg-ilmenite is lacking. Because of the low indicator mineral content in the 0.25 to 2.0 mm fraction, indicators were picked from the finer grained, 0.18 to 0.25 mm fraction to provide a sufficient number of grains for mineral chemistry characterization. It may be useful to examine the finer 0.18 to 0.25 mm fraction of any till and stream sediment samples collected in the region as this finer fraction could provide additional information on indicator mineral abundance and chemistry of source kimberlites.

The indicator mineral suite of the cobble confirms the presence of several lithologies of mantle xenoliths in the Buffalo Head Hills kimberlites: fertile garnet-lherzolite and garnet-harzburgite, sheared garnet-lherzolite, garnet-wehrlite, garnet-pyroxenite, garnet-websterite, Group II eclogite, spinel lherzolite, and chromian corundum-bearing high Al assemblages that also include Mg-Al-spinel. A study of mantle xenoliths from Buffalo Head Hills kimberlites (Aulbach et al., 2004) also confirms the presence of pyroxenite, lherzolite, sheared (metasomatized) lherzolite, harzburgite, and wehrlite.

Of particular interest is the occurrence of pink chromian corundum in the kimberlite cobble. Its abundance was not determined in this study because the sample was not systematically picked for chromian corundum. Instead, chromian corundum was picked because it looked like Cr-pyrope. In order to determine its abundance relative to the other indicator minerals identified in this study, the sample would have to be re-examined specifically for pink corundum. It is a common but minor mineral in Buffalo Head Hills kimberlites north of the K5 kimberlite and is distinct from metamorphic corundum because of its high Cr content. Chromian corundum is considered to be an additional kimberlite indicator mineral in this region but is unrelated to a kimberlite's diamond content. Several hercynite (Mg, Fe-Al-spinel) and Cr- and Al-rich magnetite grains were also found in the cobble. Since hercynite has been reported to occur in association with corundum in the Buffalo Head Hills kimberlites (Hood and McCandless, 2004), it can also be used as a kimberlite indicator mineral for the region.

Kimberlite indicator mineral abundances and compositions in the kimberlite cobble are in agreement with published data for mantle xenoliths and kimberlite indicator minerals in the Buffalo Head Hills kimberlites. The cobble's location, combined with known ice-flow directions, garnet and chromite compositions, and abundant olivine and chromian corundum suggest that it is derived from one of the northern kimberlites, most likely K14 or K6. However, due to the fact that both chromite and garnet predominantly come from mantle xenoliths, a strong link between the cobble and a specific known kimberlite cannot be established since any kimberlite in the area could have sampled mantle material of similar composition. Therefore, it is not known whether the source of the esker cobble is one of the known kimberlites in the Buffalo Head Hills or an undiscovered kimberlite. Paleocurrent directions measured in the esker face where the cobble and numerous other kimberlite clasts were found indicate a flow direction towards the south. This flow direction, combined with late-stage ice flow towards the southeast and south, suggests that the likely up-flow direction to search for the source of the kimberlite cobble is north. The closest kimberlites up-flow and up-ice are K5 and K6. Paleocurrent directions and transport distances for this esker should also be considered when interpreting indicator mineral data for stream sediments collected near the K4 esker.

FUTURE WORK

It would be useful to examine the indicator minerals of additional large kimberlite cobbles or boulders that may be found in the studied esker and in other nearby eskers to compare with data reported in this study and for known kimberlites in the region. Age dating of perovskite from kimberlite boulders and cobbles found in the local eskers may also help determine if their bedrock source is a known kimberlite.

ACKNOWLEDGMENTS

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Appendix A. Sample location information.

Sample Number	Drill hole	Material	UTM Easting	UTM Northing	Datum	UTM Zone	Sample depth from (m)	Sample depth to (m)	Province	Location	Year collected	Kimberlite name	Commodity	Sample site type	NTS sheet	Scale of survey	GSC publication
03-MPB-009	NA	kimberlite cobble	581546	6298144	NAD83	11	NA	NA	Alberta	Buffalo Head Hills	2003	NA	kimberlite	gravel pit	84B/13	local	Open File

Appendix B. Sample processing and heavy mineral fraction weight data..

Sample Number	Total weight (g)	Weight <0.180 mm (g)	Weight 0.180 to 0.250 mm- dry (g)	Weight 0.18-0.25 mm- washed (g)	Weight Total 0.18-2.0 mm fraction for heavy liquid separation (g)	Weight 0.18-2.0 mm heavy liquid separation (SG <3.2) light mineral fraction(g)	Weight 0.18-2.0 mm heavy liquid separation (SG >3.2) heavy mineral fraction(g)	Weight 0.18-2.0 mm heavy liquid separation (SG >3.2) heavy mineral ferromagnetic fraction (g)	Total weight 0.18-2.0 mm nonferromagnetic fraction (g)	Weight 0.18 to 0.25 mm nonferromagnetic fraction (g)	Weight 0.25 to 0.50 mm nonferromagnetic fraction (g)	Weight 0.5 to 1.0 mm nonferromagnetic fraction (g)	Weight 1.0 to 2.0 mm nonferromagnetic fraction (g)
03-MPB-009	1947.40	404.40	1534.00	1447.10	1447.10	1446.70	0.40	0.10	0.30	0.10	0.10	0.10	<0.01

Appendix C. Electron microprobe analyses of indicator mineral grains.
Appendix C.1 Microprobe data for garnet

Mount	Grain No.	Sample	Size (mm)	Mineral	SiO_2	TiO_2	Al_2O_3	Cr_2O_3	V_2O_3	FeO_{tot}	MnO	NiO	MgO	CaO	Na_2O	K_2O	TOTAL	Mg-#	equ. 1	CA_INT	TI	Grütter	Group#	Comment
18048	24	03-MPB-009	0.18-0.25	Cr-pyrope	40.65	0.06	15.83	9.30	0.06	6.78	0.36	0.02	18.89	6.52	0.02	0.00	98.47	83.25	-0.82	4.20	-0.32	G09	lhz	picked as Cr-pyrope
18048	26	03-MPB-009	0.18-0.25	Cr-pyrope	40.60	1.50	16.80	6.23	0.06	6.04	0.21	0.00	20.17	6.29	0.07	0.00	97.90	85.61	-1.36	4.74	1.17	G11	slhz	picked as Cr-pyrope
18048	27	03-MPB-009	0.18-0.25	Cr-pyrope	41.06	0.46	19.68	3.98	0.04	8.43	0.29	0.00	19.80	4.72	0.07	0.01	98.46	80.73	-0.35	3.72	0.02	G01	mgx	picked as Cr-pyrope
18048	28	03-MPB-009	0.18-0.25	Cr-pyrope	40.26	1.03	13.82	11.06	0.01	7.16	0.39	0.02	18.43	6.72	0.12	0.00	98.89	82.11	-0.58	3.96	0.63	G11	slhz	picked as Cr-pyrope
18048	29	03-MPB-009	0.18-0.25	Cr-pyrope	40.55	0.03	16.34	9.42	0.00	7.64	0.48	0.02	17.24	7.57	0.00	0.00	99.28	80.09	-1.84	5.22	-0.42	G09	lhz	picked as Cr-pyrope
18048	30	03-MPB-009	0.18-0.25	Cr-pyrope	41.20	0.23	17.00	8.60	0.05	7.14	0.35	0.06	18.87	6.60	0.00	0.01	100.11	82.49	-1.07	4.45	-0.16	G09	lhz	picked as Cr-pyrope
18048	31	03-MPB-009	0.18-0.25	Cr-pyrope	41.28	0.55	17.84	5.98	0.04	6.95	0.32	0.05	20.38	5.45	0.02	0.00	98.83	83.95	-0.58	3.95	0.18	G11	slhz	picked as Cr-pyrope
18048	32	03-MPB-009	0.18-0.25	Cr-pyrope	41.09	0.86	18.38	5.07	0.00	7.75	0.36	0.07	19.78	5.12	0.07	0.00	98.48	81.99	-0.48	3.85	0.46	G11	slhz	picked as Cr-pyrope
18048	33	03-MPB-009	0.18-0.25	Cr-pyrope	41.67	0.47	20.64	3.19	0.03	7.26	0.42	0.00	20.95	4.34	0.04	0.01	98.97	83.71	-0.17	3.54	0.10	G01	mgx	picked as Cr-pyrope
18048	34	03-MPB-009	0.18-0.25	Cr-pyrope	39.73	0.04	15.46	10.77	0.01	7.83	0.56	0.00	16.70	8.37	0.01	0.00	99.46	79.18	-2.30	5.67	-0.43	G12	wehr	picked as Cr-pyrope
18048	35	03-MPB-009	0.18-0.25	Cr-pyrope	40.09	0.05	15.34	10.68	0.09	7.64	0.50	0.07	16.59	8.35	0.02	0.01	99.41	79.47	-2.30	5.68	-0.41	G12	wehr	picked as Cr-pyrope
18048	36	03-MPB-009	0.18-0.25	Cr-pyrope	41.11	0.37	17.19	7.48	0.06	7.25	0.34	0.10	19.33	5.74	0.05	0.00	98.99	82.61	-0.50	3.87	-0.02	G11	slhz	picked as Cr-pyrope
18048	37	03-MPB-009	0.18-0.25	Cr-pyrope	40.70	1.06	15.42	8.26	0.01	7.17	0.39	0.06	19.57	6.10	0.11	0.00	98.73	82.96	-0.66	4.03	0.67	G11	slhz	picked as Cr-pyrope
18048	38	03-MPB-009	0.18-0.25	Cr-pyrope	39.62	0.32	12.69	13.24	0.07	6.95	0.40	0.00	18.11	6.98	0.05	0.00	98.39	82.29	-0.29	3.67	-0.08	G09	lhz	picked as Cr-pyrope
18048	39	03-MPB-009	0.18-0.25	Cr-pyrope	40.81	1.08	15.43	8.39	0.00	6.90	0.31	0.09	19.38	5.94	0.09	0.00	98.34	83.35	-0.47	3.85	0.70	G11	slhz	picked as Cr-pyrope
18048	41	03-MPB-009	0.18-0.25	Cr-pyrope	40.70	1.18	15.58	8.27	0.05	7.27	0.28	0.05	19.72	5.75	0.07	0.00	98.84	82.86	-0.31	3.68	0.79	G11	slhz	picked as Cr-pyrope
18048	44	03-MPB-009	0.18-0.25	Cr-pyrope	40.95	0.17	16.60	8.55	0.15	7.43	0.27	0.00	18.70	6.87	0.00	0.03	99.70	81.78	-1.36	4.74	-0.24	G09	lhz	picked as Cr-pyrope
18048	45	03-MPB-009	0.18-0.25	Cr-pyrope	40.74	1.08	15.46	8.73	0.05	7.31	0.41	0.00	19.46	6.09	0.08	0.00	99.32	82.59	-0.53	3.91	0.69	G11	slhz	picked as Cr-pyrope
18048	46	03-MPB-009	0.18-0.25	Cr-pyrope	40.64	0.20	16.62	8.51	0.07	7.05	0.39	0.04	18.74	6.71	0.02	0.00	98.97	82.58	-1.21	4.59	-0.20	G09	lhz	picked as Cr-pyrope
18048	47	03-MPB-009	0.18-0.25	Cr-pyrope	41.05	1.10	15.65	8.57	0.11	6.88	0.34	0.03	19.69	6.13	0.15	0.02	99.57	83.61	-0.61	3.99	0.73	G11	slhz	picked as Cr-pyrope
18048	49	03-MPB-009	0.18-0.25	Cr-pyrope	42.26	0.49	20.13	3.08	0.04	7.27	0.29	0.06	21.04	4.50	0.09	0.00	99.15	83.77	-0.35	3.73	0.12	G01	mgx	picked as Cr-pyrope
18048	50	03-MPB-009	0.18-0.25	Cr-pyrope	41.22	0.09	17.02	8.09	0.13	7.43	0.37	0.08	19.31	5.99	0.01	0.01	99.73	82.24	-0.59	3.97	-0.32	G09	lhz	picked as Cr-pyrope
18048	51	03-MPB-009	0.18-0.25	Cr-pyrope	40.91	0.05	17.23	7.61	0.07	7.10	0.27	0.01	19.38	5.95	0.04	0.00	98.59	82.96	-0.68	4.05	-0.34	G09	lhz	picked as Cr-pyrope
18048	52	03-MPB-009	0.18-0.25	Cr-pyrope	41.08	0.10	17.13	7.91	0.03	7.08	0.35	0.02	19.41	5.85	0.01	0.00	98.95	83.01	-0.50	3.87	-0.29	G09	lhz	picked as Cr-pyrope
18048	92	03-MPB-009	0.18-0.25	pyrope	40.60	0.11	22.71	0.75	0.13	13.17	0.59	0.00	15.60	5.65	0.02	0.00	99.31	67.87	-2.09	5.46	-0.60	G04	pyrox	picked as E-garnet
18048	93	03-MPB-009	0.18-0.25	pyrope	40.33	0.06	22.28	1.21	0.00	14.00	0.57	0.02	15.07	5.73	0.00	0.00	99.28	65.74	-2.05	5.42	-0.69	G04	pyrox	picked as E-garnet
18048	94	03-MPB-009	0.18-0.25	pyrope	40.47	0.05	23.12	0.40	0.00	14.30	0.36	0.00	15.09	5.62	0.02	0.02	99.42	65.30	-2.15	5.52	-0.71	G04	pyrox	picked as E-garnet
18048	97	03-MPB-009	0.18-0.25	pyrope	39.96	0.08	22.41	0.80	0.01	14.97	0.57	0.00	14.75	5.59	0.03	0.00	99.13	63.71	-2.01	5.39	-0.71	G04	pyrox	picked as E-garnet
18048	98	03-MPB-009	0.18-0.25	pyrope	40.58	0.07	22.27	0.75	0.09	15.54	0.45	0.00	14.49	5.45	0.04	0.00	99.69	62.43	-1.89	5.27	-0.75	G04	pyrox	picked as E-garnet
18048	101	03-MPB-009	0.18-0.25	pyrope	40.33	0.03	22.49	0.88	0.09	15.14	0.60	0.00	14.79	5.61	0.00	0.00	99.95	63.52	-2.01	5.39	-0.77	G04	pyrox	picked as E-garnet
18048	102	03-MPB-009	0.18-0.25	pyrope	40.37	0.05	22.50	0.81	0.07	14.88	0.55	0.01	14.64	5.36	0.00	0.02	99.24	63.69	-1.78	5.16	-0.75	G04	pyrox	picked as E-garnet
18048	103	03-MPB-009	0.18-0.25	pyrope	40.68	0.11	22.92	0.66	0.02	14.10	0.59	0.00	15.39	5.55	0.03	0.00	100.03	66.04	-2.01	5.39	-0.63	G04	pyrox	picked as E-garnet
18048	104	03-MPB-009	0.18-0.25	Cr-pyrope	40.41	1.09	15.33	8.48	0.01	6.89	0.27	0.04	19.07	5.98	0.11	0.00	97.56	83.15	-0.49	3.86	0.71	G11	slhz	picked as E-garnet
18048	109	03-MPB-009	0.18-0.25	Cr-pyrope	41.89	0.41	20.68	3.08	0.00	7.61	0.31	0.07	20.65	4.68	0.04	0.00	99.37	82.87	-0.53	3.91	0.02	G01	mgx	picked as E-garnet
18048	111	03-MPB-009	0.18-0.25	pyrope	40.52	0.10	22.57	0.66	0.00	14.48	0.61	0.01	14.75	5.48	0.02	0.01	99.19	64.49	-1.94	5.31	-0.68	G04	pyrox	picked as E-garnet
18048	112	03-MPB-009	0.18-0.25	pyrope	41.20	0.10	23.19	0.36	0.13	13.32	0.47	0.09	16.09	5.27	0.00	0.01	100.23	68.29	-1.81	5.18	-0.60	G04	pyrox	picked as E-garnet

Appendix C.1 continued.

Mount	Grain No.	Sample	Size (mm)	Mineral	SiO_2	TiO_2	Al_2O_3	Cr_2O_3	V_2O_3	FeO_{tot}	MnO	NiO	MgO	CaO	Na_2O	K_2O	TOTAL	Mg-#	equ. 1	CA_INT	TI	Grütter	Group#	Comment
18048	113	03-MPB-009	0.18-0.25	pyrope	40.34	0.08	22.25	1.31	0.00	13.41	0.42	0.05	15.05	5.77	0.00	0.00	98.70	66.68	-2.07	5.45	-0.65	G04	pyrox	picked as E-garne
18048	114	03-MPB-009	0.18-0.25	pyrope	40.42	0.12	22.78	0.70	0.04	13.90	0.62	0.00	14.77	5.68	0.02	0.00	99.04	65.46	-2.13	5.51	-0.63	G04	pyrox	picked as E-garne
18048	115	03-MPB-009	0.18-0.25	pyrope	40.27	0.11	22.58	0.72	0.02	13.24	0.48	0.03	16.03	5.55	0.03	0.00	99.04	68.34	-1.99	5.37	-0.58	G04	pyrox	picked as E-garne
18048	116	03-MPB-009	0.18-0.25	pyrope	40.24	0.05	22.65	0.70	0.06	13.93	0.66	0.01	14.74	5.70	0.04	0.00	98.73	65.36	-2.15	5.53	-0.71	G04	pyrox	picked as E-garne
18048	117	03-MPB-009	0.18-0.25	pyrope	40.49	0.04	23.19	0.22	0.00	13.90	0.38	0.00	15.73	5.14	0.00	0.00	99.09	66.86	-1.71	5.08	-0.69	G04	pyrox	picked as E-garne
18048	119	03-MPB-009	0.18-0.25	pyrope	40.64	0.02	22.86	0.72	0.00	14.08	0.68	0.00	15.07	5.55	0.00	0.03	99.62	65.61	-2.00	5.37	-0.73	G04	pyrox	picked as E-garne
18048	120	03-MPB-009	0.18-0.25	pyrope	40.45	0.07	22.26	1.44	0.00	14.07	0.64	0.00	15.05	5.70	0.00	0.00	99.67	65.60	-1.97	5.34	-0.68	G04	pyrox	picked as E-garne
18048	121	03-MPB-009	0.18-0.25	pyrope	41.67	0.01	24.02	0.10	0.13	10.07	0.25	0.00	17.94	5.40	0.00	0.00	99.58	76.05	-2.00	5.38	-0.52	G04	web	picked as E-garne
18048	123	03-MPB-009	0.18-0.25	pyrope	40.91	0.11	22.95	0.71	0.09	14.36	0.63	0.01	14.85	5.53	0.02	0.02	100.15	64.83	-1.97	5.35	-0.66	G04	pyrox	picked as E-garne
18048	124	03-MPB-009	0.18-0.25	pyrope	41.10	0.00	22.99	0.37	0.01	14.59	0.45	0.07	15.08	5.55	0.01	0.00	100.22	64.83	-2.08	5.46	-0.77	G04	pyrox	picked as E-garne
18048	125	03-MPB-009	0.18-0.25	pyrope	40.23	0.07	22.33	0.90	0.01	14.67	0.58	0.00	14.54	5.38	0.00	0.00	98.72	63.85	-1.78	5.16	-0.72	G04	pyrox	picked as E-garne
18048	126	03-MPB-009	0.18-0.25	pyrope	41.74	0.03	23.80	0.13	0.02	10.22	0.21	0.00	18.40	5.42	0.00	0.00	99.96	76.25	-2.01	5.39	-0.50	G04	web	picked as E-garne
18048	128	03-MPB-009	0.18-0.25	pyrope	40.02	0.05	22.39	0.81	0.00	15.00	0.47	0.07	14.49	5.36	0.05	0.01	98.67	63.26	-1.79	5.16	-0.75	G04	pyrox	picked as E-garne
18048	129	03-MPB-009	0.18-0.25	pyrope	40.38	0.07	23.39	0.07	0.03	11.87	0.59	0.00	15.11	7.23	0.02	0.00	98.73	69.42	-3.84	7.21	-0.60	G03	ecl	picked as E-garne
18048	130	03-MPB-009	0.18-0.25	pyrope	40.22	0.11	22.47	0.91	0.00	15.41	0.55	0.00	14.16	5.47	0.00	0.00	99.30	62.09	-1.87	5.24	-0.71	G04	pyrox	picked as E-garne
18048	132	03-MPB-009	0.18-0.25	pyrope	40.55	0.03	22.73	0.66	0.01	13.75	0.60	0.00	15.14	5.72	0.02	0.00	99.21	66.25	-2.18	5.56	-0.71	G04	pyrox	picked as E-garne
18048	133	03-MPB-009	0.18-0.25	pyrope	41.03	0.05	23.65	0.13	0.02	10.08	0.15	0.01	17.95	5.50	0.00	0.00	98.55	76.05	-2.09	5.47	-0.49	G04	web	picked as E-garne
18048	136	03-MPB-009	0.18-0.25	pyrope	40.04	0.05	22.64	0.75	0.01	14.29	0.62	0.01	14.81	5.66	0.01	0.00	98.87	64.89	-2.10	5.47	-0.72	G04	pyrox	picked as E-garne
18048	139	03-MPB-009	0.18-0.25	pyrope	39.86	0.09	22.80	0.65	0.00	14.79	0.80	0.05	14.61	5.65	0.00	0.02	99.30	63.79	-2.11	5.49	-0.70	G04	pyrox	picked as E-garne
18048	140	03-MPB-009	0.18-0.25	pyrope	40.49	0.03	22.38	1.02	0.00	15.24	0.56	0.04	14.62	5.61	0.02	0.00	99.99	63.11	-1.98	5.36	-0.78	G04	pyrox	picked as E-garne
18048	142	03-MPB-009	0.18-0.25	pyrope	40.46	0.15	22.08	1.09	0.09	14.41	0.66	0.02	14.92	5.75	0.06	0.00	99.63	64.85	-2.10	5.47	-0.62	G04	pyrox	picked as E-garne
18048	143	03-MPB-009	0.18-0.25	pyrope	40.26	0.10	22.77	0.75	0.06	14.32	0.67	0.04	14.70	5.74	0.00	0.00	99.41	64.67	-2.17	5.55	-0.67	G04	pyrox	picked as E-garne
18048	146	03-MPB-009	0.18-0.25	pyrope	41.01	0.01	22.75	0.42	0.08	14.40	0.44	0.00	15.15	5.37	0.02	0.01	99.63	65.23	-1.89	5.27	-0.75	G04	pyrox	picked as E-garne
18048	147	03-MPB-009	0.18-0.25	pyrope	40.88	0.00	23.44	0.21	0.09	13.59	0.43	0.00	15.78	5.03	0.03	0.01	99.45	67.42	-1.61	4.98	-0.71	G04	pyrox	picked as E-garne
18048	148	03-MPB-009	0.18-0.25	pyrope	40.05	0.09	22.61	0.83	0.00	14.91	0.51	0.00	14.56	5.40	0.00	0.00	98.96	63.50	-1.82	5.20	-0.71	G04	pyrox	picked as E-garne
18048	150	03-MPB-009	0.18-0.25	pyrope	40.28	0.06	22.53	0.66	0.01	13.91	0.61	0.05	14.94	5.70	0.00	0.00	98.75	65.69	-2.16	5.54	-0.69	G04	pyrox	picked as E-garne
18048	151	03-MPB-009	0.18-0.25	pyrope	39.90	0.06	22.46	0.59	0.00	14.42	0.65	0.00	14.88	5.54	0.00	0.00	98.51	64.80	-2.02	5.39	-0.71	G04	pyrox	picked as E-garne
18048	154	03-MPB-009	0.18-0.25	pyrope	41.32	0.05	23.93	0.19	0.00	10.35	0.33	0.09	17.99	5.34	0.00	0.00	99.58	75.61	-1.92	5.29	-0.49	G04	web	picked as E-garne
18048	155	03-MPB-009	0.18-0.25	pyrope	40.10	0.06	22.39	1.33	0.08	13.96	0.55	0.00	14.97	5.78	0.00	0.01	99.23	65.66	-2.07	5.45	-0.69	G04	pyrox	picked as E-garne
18048	156	03-MPB-009	0.18-0.25	pyrope	40.35	0.09	23.14	0.53	0.04	14.48	0.49	0.06	15.08	5.51	0.00	0.00	99.78	64.99	-2.00	5.38	-0.68	G04	pyrox	picked as E-garne
18048	157	03-MPB-009	0.18-0.25	pyrope	39.99	0.04	22.55	1.26	0.10	13.99	0.65	0.04	15.10	5.64	0.00	0.03	99.37	65.80	-1.95	5.32	-0.70	G04	pyrox	picked as E-garne
18048	1	03-MPB-009	0.25-0.5	Cr-pyrope	40.44	0.15	16.57	8.29	0.13	7.00	0.36	0.00	18.66	6.78	0.04	0.04	98.39	82.61	-1.34	4.71	-0.25	G09	lhz	picked as Cr-pyrop є
18048	3	03-MPB-009	0.25-0.5	Cr-pyrope	41.23	0.10	17.35	7.65	0.14	7.08	0.39	0.06	19.24	5.95	0.02	0.00	99.18	82.89	-0.66	4.03	-0.29	G09	lhz	picked as Cr-pyrop є
18048	5	03-MPB-009	0.25-0.5	Cr-pyrope	41.06	0.08	17.12	7.45	0.11	7.35	0.34	0.02	19.13	6.13	0.00	0.00	98.80	82.27	-0.89	4.27	-0.32	G09	lhz	picked as Cr-pyrop є
18048	8	03-MPB-009	0.25-0.5	Cr-pyrope	41.68	0.45	20.12	4.15	0.00	8.18	0.35	0.00	19.94	4.89	0.02	0.00	99.76	81.29	-0.48	3.85	0.02	G11	slhz	picked as Cr-pyrop є
18048	9	03-MPB-009	0.25-0.5	Cr-pyrope	40.36	0.06	16.38	9.61	0.03	7.48	0.39	0.02	17.37	7.32	0.00	0.02	99.02	80.54	-1.55	4.92	-0.38	G09	lhz	picked as Cr-pyrop є
18048	10	03-MPB-009	0.25-0.5	Cr-pyrope	40.53	0.29	14.91	10.60	0.06	6.52	0.33	0.04	18.94	6.42	0.03	0.00	98.64	83.82	-0.40	3.77	-0.08	G09	lhz	picked as Cr-pyrop є
18048	11	03-MPB-009	0.25-0.5	Cr-pyrope	41.46	0.69	19.01	4.76	0.10	7.39	0.31	0.04	20.51	5.16	0.06	0.00	99.45	83.19	-0.60	3.97	0.31	G11	slhz	picked as Cr-pyrop є
18048	13	03-MPB-009	0.25-0.5	Cr-pyrope	41.13	0.37	17.10	7.53	0.04	7.21	0.30	0.03	19.36	5.79	0.04	0.00	98.86	82.72	-0.53	3.91	-0.02	G11	slhz	picked as Cr-pyrop є
18048	18	03-MPB-009	0.25-0.5	Cr-pyrope	41.14	0.06	17.06	7.94	0.08	7.15	0.39	0.03	19.16	5.98	0.06	0.00	98.99	82.69	-0.62	3.99	-0.33	G09	lhz	picked as Cr-pyrop є
18048	19	03-MPB-009	0.25-0.5	Cr-pyrope	40.62	0.21	17.08	8.28	0.12	6.93	0.22	0.09	19.39	6.53	0.00	0.00	99.47	83.31	-1.09	4.47	-0.17	G09	lhz	picked as Cr-pyrop є
18048	20	03-MPB-009	0.25-0.5	Cr-pyrope	41.08	0.28	16.94	8.32	0.00	6.70	0.30	0.02	19.37	5.81	0.04	0.02	98.82	83.75	-0.35	3.73	-0.09	G09	lhz	picked as Cr-pyrop є
18048	21	03-MPB-009	0.25-0.5	Cr-pyrope	40.51	0.01	17.14	8.45	0.00	7.28	0.51	0.02	17.92	6.90	0.01	0.00	98.75	81.43	-1.42	4.79	-0.41	G09	lhz	picked as Cr-pyrop є
18048	22	03-MPB-009	0.25-0.5	Cr-pyrope	40.43	0.06	16.22	9.67	0.00	7.61	0.42	0.06	17.53	7.20	0.04	0.00	99.20	80.42	-1.40	4.78	-0.38	G09	lhz	picked as Cr-pyrop є
18048	23	03-MPB-009	0.25-0.5	Cr-pyrope	41.21	0.07	17.07	7.54	0.02	7.08	0.41	0.00	19.04	6.03	0.01	0.00	98.46	82.75	-0.77	4.15	-0.32	G09	lhz	picked as Cr-pyrop є
18048	53	03-MPB-009	0.25-0.5	Cr-pyrope	41.67	0.47	21.06	2.47	0.02	7.64	0.28	0.00	21.00	4.29	0.06	0.00	98.90	83.05	-0.30	3.67	0.08	G01	mgx	picked as E-garne
18048	54	03-MPB-009	0.25-0.5	pyrope	40.38	0.16	22.72	0.70	0.00	13.15	0.60	0.00	15.89	5.56	0.04	0.00	99.14	68.30	-2.00	5.38	-0.54	G04	pyrox	picked as E-garne
18048	55	03-MPB-009	0.25-0.5	pyrope	40.99	0.13	22.62	0.70	0.01	13.59	0.60	0.00	15.52	5.35	0.01	0.01	99.49	67.07	-1.80	5.17	-0.60	G04	pyrox	picked as E-garne
18048	56	03-MPB-009	0.25-0.5	pyrope	41.36	0.51	21.49	1.98	0.00	7.66	0.28	0.07	20.88	4.10	0.04	0.01	98.35	82.93	-0.23	3.61	0.13	G01	mgx	picked as E-garne
18048	57	03-MPB-009	0.25-0.5	Cr-pyrope	41.85	0.43	21.42	2.08	0.04	7.52	0.23	0.03	21.08	4.16	0.05	0.00	98.85	83.31	-0.27	3.64	0.05	G01	mgx	picked as E-garne
18048	58	03-MPB-009	0.25-0.5	pyrope	40.08	0.06	22.62	0.75	0.04	14.03	0.61	0.02	15.05	5.61	0.02	0.00	98.89	65.67	-2.05	5.42	-0.69	G04	pyrox	picked as E-garne
18048	59	03-MPB-009	0.25-0.5	pyrope	41.30	0.08	23.42	0.19	0.08	10.42	0.25	0.06	17.97	5.38	0.02	0.00	99.15	75.44	-1.95	5.33	-0.47	G04	web	picked as E-garne
18048	60	03-MPB-009	0.25-0.5	pyrope	40.75	0.03	22.15	1.16	0.04	14.23	0.68	0.04	15.57	5.77	0.03	0.01	100.43	66.11	-2.10	5.48	-0.71	G04	pyrox	picked as E-garne

Appendix C1 continued.

Mount	Grain No.	Sample	Size (mm)	Mineral	SiO_2	TiO_2	Al_2O_3	Cr_2O_3	V_2O_3	FeO_{tot}	MnO	NiO	MgO	CaO	Na_2O	K_2O	TOTAL	Mg-#	equ. 1	CA_INT	TI	Grütter	Group#	Comment
18048	61	03-MPB-009	0.25-0.5	pyrope	40.79	0.11	22.85	0.81	0.07	14.11	0.63	0.06	15.10	5.53	0.00	0.01	100.04	65.61	-1.96	5.33	-0.65	G04	pyrox	picked as E-garnet
18048	62	03-MPB-009	0.25-0.5	pyrope	40.64	0.07	22.49	0.83	0.00	14.81	0.54	0.01	14.49	5.48	0.00	0.00	99.36	63.56	-1.90	5.28	-0.73	G04	pyrox	picked as E-garnet
18048	64	03-MPB-009	0.25-0.5	pyrope	40.60	0.00	23.11	0.33	0.08	12.89	0.48	0.00	16.29	5.37	0.06	0.00	99.16	69.25	-1.92	5.29	-0.68	G04	pyrox	picked as E-garnet
18048	65	03-MPB-009	0.25-0.5	pyrope	40.57	0.10	22.37	1.33	0.06	13.81	0.61	0.00	15.09	5.72	0.00	0.01	99.66	66.06	-2.01	5.38	-0.64	G04	pyrox	picked as E-garnet
18048	66	03-MPB-009	0.25-0.5	pyrope	40.36	0.11	21.93	1.20	0.04	13.52	0.59	0.07	15.00	5.64	0.00	0.01	98.45	66.42	-1.96	5.34	-0.63	G04	pyrox	picked as E-garnet
18048	67	03-MPB-009	0.25-0.5	pyrope	40.22	0.04	22.52	0.74	0.09	14.18	0.70	0.02	15.20	5.50	0.05	0.00	99.21	65.65	-1.94	5.31	-0.72	G04	pyrox	picked as E-garnet
18048	68	03-MPB-009	0.25-0.5	pyrope	40.47	0.02	22.19	1.32	0.01	13.74	0.51	0.00	14.92	5.60	0.02	0.00	98.79	65.93	-1.89	5.27	-0.73	G04	pyrox	picked as E-garnet
18048	69	03-MPB-009	0.25-0.5	pyrope	40.86	0.05	23.32	0.53	0.13	12.85	0.50	0.01	16.12	5.32	0.00	0.00	99.68	69.10	-1.81	5.19	-0.63	G04	pyrox	picked as E-garnet
18048	70	03-MPB-009	0.25-0.5	pyrope	40.64	0.06	22.12	1.27	0.02	13.59	0.55	0.05	15.36	5.62	0.02	0.00	99.28	66.82	-1.93	5.30	-0.67	G04	pyrox	picked as E-garnet
18048	71	03-MPB-009	0.25-0.5	Cr-pyrope	41.43	0.36	20.64	3.03	0.06	7.64	0.33	0.00	20.74	4.75	0.03	0.00	99.00	82.87	-0.61	3.99	-0.03	G01	mgx	picked as E-garnet
18048	72	03-MPB-009	0.25-0.5	pyrope	40.15	0.13	22.51	0.52	0.03	14.57	0.76	0.00	14.78	5.64	0.00	0.00	99.09	64.38	-2.13	5.51	-0.64	G04	pyrox	picked as E-garnet
18048	73	03-MPB-009	0.25-0.5	pyrope	39.83	0.05	22.58	0.86	0.07	15.29	0.58	0.00	14.37	5.44	0.06	0.01	99.07	62.62	-1.85	5.22	-0.76	G04	pyrox	picked as E-garnet
18048	74	03-MPB-009	0.25-0.5	pyrope	40.27	0.08	22.45	0.64	0.03	13.74	0.65	0.04	14.91	5.51	0.00	0.01	98.31	65.92	-1.98	5.35	-0.67	G04	pyrox	picked as E-garnet
18048	75	03-MPB-009	0.25-0.5	pyrope	41.43	0.04	23.63	0.18	0.04	10.52	0.26	0.02	17.96	5.38	0.00	0.00	99.47	75.27	-1.96	5.34	-0.51	G04	web	picked as E-garnet
18048	76	03-MPB-009	0.25-0.5	pyrope	40.57	0.14	22.73	0.74	0.06	14.37	0.62	0.00	15.19	5.58	0.02	0.02	99.99	65.34	-2.02	5.39	-0.62	G04	pyrox	picked as E-garnet
18048	77	03-MPB-009	0.25-0.5	pyrope	40.23	0.07	22.36	0.66	0.07	14.39	0.59	0.03	14.60	5.51	0.02	0.00	98.51	64.39	-1.97	5.34	-0.71	G04	pyrox	picked as E-garnet
18048	80	03-MPB-009	0.25-0.5	pyrope	41.36	0.07	23.84	0.23	0.03	10.39	0.34	0.00	18.00	5.57	0.02	0.00	99.83	75.53	-2.14	5.52	-0.47	G04	web	picked as E-garnet
18048	81	03-MPB-009	0.25-0.5	pyrope	40.75	0.09	22.56	0.61	0.13	14.03	0.68	0.02	14.88	5.48	0.03	0.00	99.24	65.40	-1.95	5.33	-0.67	G04	pyrox	picked as E-garnet
18048	82	03-MPB-009	0.25-0.5	pyrope	40.37	0.07	22.58	0.61	0.03	13.81	0.63	0.00	15.20	5.45	0.00	0.00	98.75	66.25	-1.92	5.30	-0.67	G04	pyrox	picked as E-garnet
18048	84	03-MPB-009	0.25-0.5	pyrope	41.01	0.06	23.57	0.09	0.00	10.19	0.27	0.00	18.08	5.55	0.00	0.00	98.82	75.97	-2.15	5.53	-0.47	G04	web	picked as E-garnet
18048	86	03-MPB-009	0.25-0.5	pyrope	40.00	0.12	22.69	0.76	0.00	13.58	0.58	0.06	15.05	5.57	0.00	0.00	98.41	66.40	-2.00	5.38	-0.62	G04	pyrox	picked as E-garnet
18048	87	03-MPB-009	0.25-0.5	pyrope	41.33	0.09	23.49	0.19	0.01	10.38	0.28	0.00	17.68	5.47	0.00	0.00	98.92	75.22	-2.05	5.42	-0.46	G04	web	picked as E-garnet
18048	88	03-MPB-009	0.25-0.5	pyrope	40.18	0.08	22.48	0.76	0.06	15.08	0.55	0.00	14.66	5.36	0.00	0.00	99.22	63.40	-1.80	5.17	-0.72	G04	pyrox	picked as E-garnet
18048	89	03-MPB-009	0.25-0.5	pyrope	40.34	0.04	22.84	0.98	0.04	14.73	0.52	0.00	14.57	5.47	0.00	0.03	99.53	63.81	-1.85	5.22	-0.75	G04	pyrox	picked as E-garnet
18048	90	03-MPB-009	0.25-0.5	pyrope	41.22	0.09	23.50	0.19	0.05	10.38	0.26	0.00	18.06	5.40	0.00	0.00	99.15	75.62	-1.98	5.35	-0.46	G04	web	picked as E-garnet
18048	91	03-MPB-009	0.25-0.5	pyrope	41.25	0.00	23.56	0.20	0.02	10.42	0.28	0.00	18.10	5.13	0.03	0.00	98.96	75.59	-1.71	5.08	-0.54	G04	web	picked as E-garnet

Appendix C.2 Microprobe data for chromite.

Mount	Grain No.	Sample	Size (mm)	Mineral	Nb_2O_5	SiO_2	TiO_2	Al_2O_3	Cr_2O_3	V_2O_3	FeO_{tot}	MnO	CoO	NiO	ZnO	MgO	CaO	As_2O_3	SO_3	TOTAL
18048	2	03-MPB-009	0.25-0.5	chromite		0.02	0.06	24.46	42.64	0.43	20.48	0.10	0.04			9.89	0.02	0.04	0.00	98.13
18049	1	03-MPB-009	0.25-0.5	Cr-spinel	0.09	0.06	0.02	50.50	12.41	0.26	19.34	0.09	0.11	0.26	0.20	16.47	0.02	0.00	0.00	99.7
18049	2	03-MPB-009	0.25-0.5	chromite	0.00	0.23	1.36	4.32	58.70	0.36	22.93	0.34	0.10	0.08	0.08	10.52	0.00	0.02	0.08	98.9
18049	3	03-MPB-009	0.25-0.5	Cr-spinel	0.01	0.04	0.10	39.96	27.11	0.17	16.18	0.21	0.09	0.24	0.32	15.56	0.00	0.05	0.00	100.0
18049	4	03-MPB-009	0.25-0.5	chromite	0.19	0.04	0.17	4.91	62.20	0.16	21.20	0.33	0.04	0.05	0.04	10.38	0.00	0.03	0.06	99.6
18049	5	03-MPB-009	0.25-0.5	chromite	0.00	0.00	0.05	14.50	54.73	0.32	17.07	0.23	0.02	0.10	0.21	12.01	0.00	0.00	0.00	99.2
18049	6	03-MPB-009	0.25-0.5	Cr-spinel	0.09	0.05	0.08	51.99	12.04	0.05	19.93	0.23	0.05	0.09	0.20	15.47	0.04	0.01	0.00	100.2
18049	7	03-MPB-009	0.25-0.5	chromite	0.00	0.06	1.11	8.82	59.35	0.24	16.98	0.23	0.00	0.04	0.08	12.59	0.00	0.00	0.05	99.5
18049	8	03-MPB-009	0.25-0.5	Cr-spinel	0.01	0.10	0.00	32.96	32.33	0.29	20.26	0.27	0.09	0.19	0.09	13.78	0.00	0.00	0.07	100.3
18049	9	03-MPB-009	0.25-0.5	Cr-spinel	0.00	0.04	0.13	36.97	21.85	0.22	28.20	0.06	0.06	0.37	0.28	11.87	0.01	0.00	0.00	100.0
18049	10	03-MPB-009	0.25-0.5	Cr-spinel	0.02	0.01	0.11	43.73	19.67	0.18	22.35	0.23	0.07	0.20	0.14	13.33	0.02	0.07	0.00	100.1
18049	11	03-MPB-009	0.25-0.5	Cr-spinel	0.21	0.07	0.04	32.92	34.89	0.26	16.77	0.19	0.09	0.01	0.46	13.62	0.00	0.04	0.05	99.3
18049	12	03-MPB-009	0.25-0.5	Cr-spinel	0.00	0.00	0.17	39.43	29.03	0.27	14.75	0.28	0.08	0.09	0.26	15.60	0.00	0.12	0.00	100.1
18049	13	03-MPB-009	0.25-0.5	chromite	0.06	0.09	2.60	10.55	50.91	0.07	21.35	0.39	0.09	0.18	0.00	13.58	0.04	0.01	0.01	99.8
18049	14	03-MPB-009	0.25-0.5	chromite	0.00	0.07	0.76	19.52	48.25	0.20	17.04	0.34	0.07	0.11	0.31	13.98	0.02	0.12	0.00	100.7
18049	15	03-MPB-009	0.25-0.5	Cr-spinel	0.07	0.03	0.02	39.89	28.52	0.00	15.00	0.20	0.06	0.12	0.37	15.45	0.02	0.06	0.00	99.7
18049	16	03-MPB-009	0.25-0.5	Cr-spinel	0.09	0.09	0.09	39.88	27.95	0.22	13.97	0.23	0.11	0.18	0.27	15.72	0.01	0.00	0.01	98.7
18049	17	03-MPB-009	0.25-0.5	chromite	0.00	0.11	2.68	11.33	46.14	0.01	22.82	0.48	0.11	0.18	0.00	13.96	0.04	0.08	0.02	97.8
18049	18	03-MPB-009	0.25-0.5	Cr-spinel	0.00	0.09	0.14	33.03	32.20	0.23	19.33	0.19	0.08	0.22	0.31	13.63	0.01	0.06	0.00	99.4
18049	19	03-MPB-009	0.25-0.5	Cr-spinel	0.06	0.02	0.05	42.57	21.31	0.12	20.82	0.21	0.11	0.18	0.14	13.56	0.02	0.00	0.00	99.1
18049	21	03-MPB-009	0.25-0.5	chromite	0.03	0.09	0.07	8.33	60.03	0.18	19.03	0.29	0.02	0.06	0.07	11.46	0.00	0.06	0.01	99.6

Appendix C.2 continued.

Mount	Grain No.	Sample	Size (mm)	Mineral	Nb_2O_5	SiO_2	TiO_2	Al_2O_3	Cr_2O_3	V_2O_3	FeO_{tot}	MnO	CoO	NiO	ZnO	MgO	CaO	As_2O_3	SO_3	TOTAL
18049	22	03-MPB-009	0.25-0.5	Cr-spinel	0.07	0.00	0.05	35.86	31.90	0.23	16.35	0.20	0.06	0.09	0.20	14.47	0.01	0.00	0.00	99.4
18049	23	03-MPB-009	0.25-0.5	AlCr-mt	0.00	0.05	8.24	10.53	20.40	0.07	45.26	0.39	0.09	0.00	0.00	13.43	0.06	0.01	0.04	98.5
18049	24	03-MPB-009	0.25-0.5	Cr-spinel	0.00	0.04	0.12	39.33	29.17	0.18	14.55	0.28	0.00	0.09	0.41	15.33	0.01	0.10	0.03	99.6
18049	25	03-MPB-009	0.25-0.5	Cr-spinel	0.12	0.05	0.07	39.80	28.21	0.17	13.92	0.22	0.01	0.18	0.21	16.08	0.00	0.00	0.06	98.9
18049	26	03-MPB-009	0.25-0.5	Cr-spinel	0.21	0.09	0.07	38.42	30.57	0.19	14.62	0.19	0.08	0.09	0.31	15.60	0.03	0.00	0.00	100.2
18049	27	03-MPB-009	0.25-0.5	chromite	0.00	0.12	1.07	8.75	59.35	0.19	17.73	0.42	0.13	0.07	0.12	11.99	0.00	0.00	0.00	99.8
18049	28	03-MPB-009	0.25-0.5	chromite	0.23	0.14	3.41	12.06	43.97	0.11	25.42	0.44	0.08	0.08	0.10	13.36	0.05	0.00	0.00	99.1
18049	29	03-MPB-009	0.25-0.5	Cr-spinel	0.07	0.03	0.17	37.91	30.00	0.07	15.23	0.14	0.12	0.15	0.20	15.46	0.00	0.04	0.02	99.5
18049	30	03-MPB-009	0.25-0.5	Cr-spinel	0.00	0.04	0.15	37.76	21.51	0.25	27.21	0.10	0.05	0.27	0.13	11.95	0.03	0.00	0.05	99.5
18049	31	03-MPB-009	0.25-0.5	Cr-spinel	0.00	0.02	0.05	36.30	33.01	0.14	15.39	0.23	0.11	0.15	0.33	14.87	0.02	0.03	0.03	100.7
18049	32	03-MPB-009	0.25-0.5	Cr-spinel	0.00	0.05	0.13	34.66	34.60	0.30	15.71	0.28	0.13	0.14	0.24	14.55	0.04	0.00	0.06	100.8
18049	33	03-MPB-009	0.25-0.5	Cr-spinel	0.15	0.02	0.00	37.04	31.22	0.20	14.66	0.21	0.03	0.14	0.20	15.07	0.00	0.04	0.08	98.9
18049	34	03-MPB-009	0.25-0.5	chromite	0.01	0.16	0.35	4.17	63.92	0.15	18.63	0.21	0.07	0.10	0.11	12.26	0.00	0.02	0.00	100.0
18049	35	03-MPB-009	0.25-0.5	chromite	0.13	0.72	3.66	11.45	39.74	0.06	25.91	0.41	0.13	0.12	0.12	13.40	0.88	0.05	0.09	96.1
18049	36	03-MPB-009	0.25-0.5	Cr-spinel	0.00	0.05	0.06	37.26	30.39	0.21	16.02	0.12	0.01	0.12	0.26	15.23	0.01	0.03	0.00	99.7
18049	37	03-MPB-009	0.25-0.5	Cr-spinel	0.00	0.05	0.01	37.69	30.85	0.11	15.46	0.18	0.16	0.19	0.23	15.20	0.03	0.04	0.00	100.2
18049	38	03-MPB-009	0.25-0.5	Cr-spinel	0.16	0.00	0.04	37.68	30.69	0.08	15.92	0.14	0.05	0.18	0.20	15.07	0.00	0.08	0.01	100.1
18049	39	03-MPB-009	0.25-0.5	Cr-spinel	0.12	0.02	0.09	37.63	30.15	0.16	15.76	0.21	0.01	0.12	0.24	15.13	0.00	0.00	0.04	99.5
18049	40	03-MPB-009	0.25-0.5	Cr-spinel	0.09	0.02	0.03	33.92	30.49	0.23	19.87	0.18	0.06	0.17	0.41	14.10	0.02	0.02	0.03	99.5
18049	41	03-MPB-009	0.25-0.5	Cr-spinel	0.00	0.03	0.11	40.27	27.44	0.19	14.52	0.25	0.08	0.25	0.44	15.72	0.00	0.07	0.02	99.4
18049	42	03-MPB-009	0.25-0.5	chromite	0.06	0.09	0.41	4.20	63.60	0.03	18.49	0.22	0.00	0.13	0.04	12.34	0.03	0.00	0.05	99.5
18049	43	03-MPB-009	0.25-0.5	Cr-spinel	0.00	0.04	0.05	51.97	12.33	0.08	19.90	0.16	0.06	0.04	0.08	15.39	0.02	0.10	0.02	100.2
18049	44	03-MPB-009	0.25-0.5	chromite	0.00	2.34	2.80	9.09	39.63	0.10	22.18	0.47	0.00	0.04	0.04	13.64	0.80	0.02	0.01	88.8
18049	45	03-MPB-009	0.25-0.5	chromite	0.01	0.04	0.39	8.99	61.97	0.23	14.96	0.20	0.10	0.11	0.01	13.36	0.02	0.02	0.00	100.4
18049	46	03-MPB-009	0.25-0.5	chromite	0.00	0.56	3.01	13.02	44.70	0.20	23.13	0.29	0.05	0.00	0.03	14.62	0.04	0.06	0.02	99.2
18049	47	03-MPB-009	0.25-0.5	chromite	0.08	0.06	3.21	9.84	46.84	0.12	24.33	0.41	0.08	0.18	0.07	13.66	0.05	0.00	0.05	98.8
18049	48	03-MPB-009	0.25-0.5	Cr-spinel	0.00	0.02	0.07	37.61	30.72	0.09	15.26	0.19	0.14	0.16	0.33	15.41	0.01	0.09	0.00	100.1
18049	49	03-MPB-009	0.25-0.5	Cr-spinel	0.00	0.06	0.03	36.85	32.18	0.18	15.11	0.23	0.07	0.12	0.29	14.94	0.00	0.05	0.03	100.1
18049	50	03-MPB-009	0.25-0.5	chromite	0.00	0.24	1.14	3.51	61.83	0.13	19.68	0.35	0.06	0.06	0.07	12.09	0.00	0.00	0.00	98.9
18049	51	03-MPB-009	0.25-0.5	chromite	0.04	0.18	0.30	4.19	64.72	0.14	18.68	0.22	0.15	0.13	0.00	12.12	0.01	0.04	0.00	100.7
18049	52	03-MPB-009	0.25-0.5	chromite	0.14	0.25	3.24	4.11	56.02	0.17	22.36	0.28	0.08	0.24	0.01	12.11	0.06	0.00	0.00	98.7
18049	53	03-MPB-009	0.25-0.5	Cr-spinel	0.07	0.00	0.02	36.51	31.88	0.12	15.65	0.31	0.07	0.08	0.42	14.94	0.00	0.01	0.08	100.1
18049	55	03-MPB-009	0.25-0.5	Cr-spinel	0.00	0.08	0.04	40.56	28.91	0.20	13.81	0.19	0.10	0.05	0.32	16.22	0.00	0.02	0.00	100.4
18049	56	03-MPB-009	0.25-0.5	spinel	0.00	0.04	0.02	65.38	0.22	0.15	12.09	0.07	0.07	0.10	0.04	21.10	0.00	0.00	0.00	99.2
18049	57	03-MPB-009	0.25-0.5	Cr-spinel	0.17	0.10	0.05	40.35	26.64	0.20	16.47	0.19	0.12	0.26	0.39	15.58	0.00	0.03	0.00	100.3
18049	58	03-MPB-009	0.25-0.5	Cr-spinel	0.00	0.03	0.12	40.47	28.49	0.12	14.72	0.17	0.10	0.11	0.40	15.83	0.00	0.00	0.00	100.5
18049	59	03-MPB-009	0.25-0.5	chromite	0.14	0.10	0.32	9.05	60.94	0.20	14.83	0.29	0.02	0.08	0.15	12.56	0.02	0.07	0.02	98.5
18049	60	03-MPB-009	0.25-0.5	Cr-spinel	0.09	0.06	0.00	35.93	32.57	0.13	14.99	0.21	0.06	0.10	0.28	14.70	0.00	0.00	0.03	99.0
18049	61	03-MPB-009	0.25-0.5	Cr-spinel	0.00	0.05	0.06	50.57	11.87	0.23	19.77	0.13	0.06	0.17	0.34	16.37	0.00	0.03	0.02	99.6
18049	62	03-MPB-009	0.25-0.5	Cr-spinel	0.12	0.04	0.06	50.03	13.34	0.17	19.87	0.11	0.02	0.20	0.03	14.94	0.02	0.00	0.10	98.9
18049	63	03-MPB-009	0.25-0.5	Cr-spinel	0.01	0.02	0.09	35.57	33.16	0.04	15.39	0.17	0.09	0.15	0.20	14.79	0.02	0.00	0.01	99.7
18049	64	03-MPB-009	0.25-0.5	Cr-spinel	0.00	0.04	0.14	35.77	33.40	0.15	15.44	0.27	0.04	0.17	0.27	14.72	0.02	0.00	0.01	100.4
18049	65	03-MPB-009	0.25-0.5	Cr-spinel	0.00	0.00	0.11	37.00	31.92	0.15	15.07	0.12	0.13	0.07	0.25	14.96	0.02	0.00	0.06	99.9
18049	66	03-MPB-009	0.25-0.5	TiAlCr-mt	0.00	0.05	7.51	12.18	21.89	0.00	42.39	0.42	0.10	0.10	0.00	13.59	0.08	0.00	0.00	98.3
18049	67	03-MPB-009	0.25-0.5	chromite	0.17	0.27	4.28	6.78	49.43	0.26	25.30	0.44	0.00	0.20	0.07	12.34	0.00	0.00	0.09	99.2
18049	68	03-MPB-009	0.25-0.5	chromite	0.00	0.14	0.20	18.36	42.67	0.13	23.68	0.27	0.01	0.19	0.10	12.97	0.08	0.05	0.03	98.7
18049	69	03-MPB-009	0.25-0.5	Cr-spinel	0.00	0.00	0.12	39.64	28.45	0.18	15.52	0.21	0.11	0.10	0.25	15.10	0.00	0.08	0.03	99.8
18049	70	03-MPB-009	0.25-0.5	Cr-spinel	0.00	0.02	0.04	35.99	32.85	0.26	15.60	0.28	0.13	0.10	0.18	14.74	0.02	0.04	0.08	100.3

Appendix C.2 continued.

Mount	Grain No.	Sample	Size (mm)	Mineral	Nb_2O_5	SiO_2	TiO_2	Al_2O_3	Cr_2O_3	V_2O_3	FeO_{tot}	MnO	CoO	NiO	ZnO	MgO	CaO	As_2O_3	SO_3	TOTAL
18049	71	03-MPB-009	0.25-0.5	TiAlCr-mt	0.00	2.78	7.79	8.51	15.14	0.06	43.61	0.43	0.04	0.03	0.00	14.76	0.79	0.07	0.00	91.2
18049	73	03-MPB-009	0.25-0.5	chromite	0.00	0.07	2.09	13.70	48.48	0.19	20.09	0.29	0.12	0.19	0.08	13.61	0.03	0.00	0.05	98.9
18049	74	03-MPB-009	0.25-0.5	spinel	0.14	0.04	0.06	66.14	0.57	0.09	11.27	0.04	0.00	0.05	0.18	21.10	0.01	0.00	0.00	99.5
18049	75	03-MPB-009	0.25-0.5	chromite	0.09	0.14	1.83	13.41	50.52	0.15	19.77	0.21	0.16	0.16	0.18	13.65	0.00	0.01	0.00	100.0
18049	76	03-MPB-009	0.25-0.5	Cr-spinel	0.00	0.05	0.04	51.76	12.33	0.14	19.77	0.20	0.14	0.08	0.13	15.37	0.00	0.00	0.10	100.1
18049	77	03-MPB-009	0.25-0.5	chromite	0.00	0.16	3.97	3.92	52.87	0.22	26.05	0.27	0.11	0.27	0.02	11.02	0.03	0.00	0.00	98.7
18049	78	03-MPB-009	0.25-0.5	Cr-spinel	0.00	0.00	0.10	40.11	28.27	0.17	14.21	0.20	0.14	0.19	0.25	15.97	0.00	0.00	0.00	99.6
18049	79	03-MPB-009	0.25-0.5	chromite	0.06	0.25	5.29	14.13	37.25	0.12	27.23	0.23	0.09	0.19	0.19	14.38	0.02	0.02	0.02	99.2
18049	80	03-MPB-009	0.25-0.5	Cr-spinel	0.01	0.00	0.03	36.95	30.26	0.14	16.02	0.17	0.09	0.10	0.31	15.30	0.01	0.01	0.00	99.4
18049	81	03-MPB-009	0.25-0.5	Cr-spinel	0.06	0.07	0.08	37.65	30.96	0.23	14.77	0.19	0.09	0.15	0.20	15.38	0.00	0.10	0.09	99.9
18049	82	03-MPB-009	0.25-0.5	Cr-spinel	0.13	0.05	0.06	38.82	30.07	0.24	14.98	0.34	0.08	0.16	0.27	15.43	0.00	0.00	0.00	100.4
18049	83	03-MPB-009	0.25-0.5	Cr-spinel	0.00	0.01	0.10	46.69	18.24	0.16	20.08	0.30	0.02	0.08	0.21	14.58	0.02	0.14	0.03	100.6
18049	84	03-MPB-009	0.25-0.5	chromite	0.18	0.18	1.87	12.87	50.40	0.08	19.15	0.26	0.04	0.20	0.03	13.71	0.00	0.12	0.05	98.8
18049	85	03-MPB-009	0.25-0.5	Cr-spinel	0.00	0.00	0.12	41.23	28.25	0.13	14.17	0.22	0.03	0.20	0.20	15.94	0.00	0.03	0.00	100.5
18049	86	03-MPB-009	0.25-0.5	Cr-spinel	0.06	0.05	0.05	37.35	30.91	0.20	14.70	0.21	0.07	0.07	0.26	15.01	0.00	0.04	0.00	98.9
18049	88	03-MPB-009	0.25-0.5	Cr-spinel	0.02	0.10	0.01	38.78	29.88	0.19	14.65	0.30	0.10	0.14	0.30	15.23	0.00	0.00	0.02	99.6
18049	90	03-MPB-009	0.25-0.5	Cr-spinel	0.00	0.05	0.06	40.98	27.88	0.16	14.03	0.19	0.03	0.29	0.23	15.89	0.00	0.00	0.08	99.8
18049	92	03-MPB-009	0.25-0.5	chromite	0.00	0.30	3.97	4.16	53.73	0.39	24.18	0.25	0.03	0.22	0.00	11.95	0.02	0.01	0.04	98.9
18049	93	03-MPB-009	0.25-0.5	Cr-spinel	0.05	0.02	0.07	40.36	27.98	0.23	13.96	0.14	0.06	0.23	0.31	16.09	0.01	0.00	0.08	99.5
18049	94	03-MPB-009	0.25-0.5	chromite	0.00	0.09	1.93	3.25	55.76	0.23	27.80	0.49	0.04	0.19	0.21	9.06	0.01	0.03	0.00	99.0
18049	95	03-MPB-009	0.25-0.5	Cr-spinel	0.00	0.00	0.11	50.49	12.19	0.21	18.68	0.01	0.02	0.21	0.33	16.57	0.02	0.04	0.11	99.0
18049	96	03-MPB-009	0.25-0.5	Cr-spinel	0.00	0.05	0.09	41.66	26.79	0.08	14.26	0.26	0.06	0.16	0.24	16.22	0.00	0.05	0.06	99.9
18049	97	03-MPB-009	0.25-0.5	Cr-spinel	0.20	0.03	0.16	38.72	29.84	0.14	15.47	0.15	0.12	0.10	0.25	15.38	0.00	0.06	0.05	100.4
18049	98	03-MPB-009	0.25-0.5	chromite	0.07	0.14	3.73	4.23	52.90	0.25	25.94	0.34	0.07	0.13	0.07	10.56	0.00	0.03	0.12	98.4
18049	99	03-MPB-009	0.18-0.25	spinel	0.00	0.00	0.05	67.96	0.23	0.00	8.89	0.00	0.02	0.08	0.25	22.44	0.00	0.04	0.00	100.0
18049	100	03-MPB-009	0.18-0.25	spinel	0.10	0.03	0.03	68.05	0.20	0.10	8.81	0.00	0.12	0.13	0.14	22.33	0.00	0.04	0.02	100.0

Appendix C.3 Microprobe data for diopside.

Mount	Grain No.	Sample	Size (mm)	Mineral	SiO_2	TiO_2	Al_2O_3	Cr_2O_3	V_2O_3	FeO_{tot}	MnO	NiO	MgO	CaO	Na_2O	K_2O	TOTAL	Mg-#
18048	158	03-MPB-009	0.25-0.5	Cr-diopside	55.54	0.04	1.14	0.65	0.03	2.29	0.10	0.03	18.19	20.99	0.88	0.15	100.03	93.4
18048	159	03-MPB-009	0.25-0.5	Cr-diopside	55.38	0.06	1.53	0.96	0.00	2.81	0.08	0.13	18.12	19.38	1.30	0.05	99.79	92.0
18048	160	03-MPB-009	0.25-0.5	Cr-diopside	55.59	0.19	1.56	0.96	0.10	3.11	0.14	0.04	18.90	18.64	1.26	0.06	100.55	91.6
18048	161	03-MPB-009	0.25-0.5	Cr-diopside	55.42	0.16	1.76	1.80	0.17	2.67	0.08	0.02	17.31	18.97	1.79	0.04	100.18	92.0
18048	162	03-MPB-009	0.25-0.5	Cr-diopside	52.75	0.56	4.97	1.11	0.12	3.62	0.10	0.04	14.55	21.21	1.53	0.00	100.56	87.8
18048	163	03-MPB-009	0.25-0.5	Cr-diopside	55.08	0.19	1.75	1.86	0.11	2.68	0.08	0.12	17.36	18.93	1.80	0.03	99.99	92.0
18048	164	03-MPB-009	0.25-0.5	Cr-diopside	53.12	0.45	4.95	0.97	0.10	2.80	0.08	0.00	14.09	22.41	1.42	0.00	100.39	90.0
18048	165	03-MPB-009	0.25-0.5	Cr-diopside	55.15	0.17	1.62	0.96	0.00	2.93	0.12	0.07	17.96	19.69	1.48	0.09	100.23	91.6
18048	166	03-MPB-009	0.25-0.5	Cr-diopside	52.17	0.23	5.76	0.79	0.10	2.39	0.14	0.00	14.84	23.29	0.50	0.01	100.23	91.7
18048	167	03-MPB-009	0.18-0.25	Cr-diopside	52.58	0.53	4.99	1.01	0.01	2.93	0.10	0.01	14.44	21.86	1.61	0.01	100.08	89.8
18048	168	03-MPB-009	0.18-0.25	Cr-diopside	55.53	0.09	1.75	2.30	0.11	2.24	0.12	0.02	16.07	20.39	1.68	0.18	100.48	92.7
18048	169	03-MPB-009	0.18-0.25	Cr-diopside	55.23	0.14	1.21	1.15	0.03	2.80	0.14	0.04	18.72	19.53	1.15	0.06	100.22	92.3
18048	170	03-MPB-009	0.18-0.25	Cr-diopside	55.37	0.15	1.51	1.54	0.08	2.95	0.05	0.12	17.56	19.29	1.50	0.05	100.17	91.4
18048	171	03-MPB-009	0.18-0.25	Cr-diopside	55.60	0.04	1.25	1.11	0.04	2.78	0.13	0.07	18.31	19.86	1.12	0.04	100.34	92.2
18048	172	03-MPB-009	0.18-0.25	Cr-diopside	55.45	0.11	1.48	1.13	0.00	3.02	0.07	0.01	17.87	19.86	1.29	0.10	100.40	91.3
18048	173	03-MPB-009	0.18-0.25	Cr-diopside	55.21	0.22	1.71	1.15	0.00	2.93	0.10	0.08	18.16	18.75	1.52	0.07	99.90	91.7
18048	174	03-MPB-009	0.18-0.25	Cr-diopside	55.31	0.18	1.68	1.14	0.08	2.96	0.13	0.00	18.13	19.08	1.48	0.04	100.21	91.6

Appendix C.3 continued.

Mount	Grain No.	Sample	Size (mm)	Mineral	SiO_2	TiO_2	Al_2O_3	Cr_2O_3	V_2O_3	FeO_{tot}	MnO	NiO	MgO	CaO	Na_2O	K_2O	TOTAL	Mg-#
18048	175	03-MPB-009	0.18-0.25	Cr-diopside	55.58	0.04	1.31	1.18	0.01	2.60	0.14	0.03	18.36	19.80	1.22	0.05	100.33	92.6
18048	176	03-MPB-009	0.18-0.25	Cr-diopside	55.48	0.08	1.13	1.15	0.01	2.46	0.18	0.10	18.17	20.31	1.02	0.13	100.21	92.9
18048	177	03-MPB-009	0.18-0.25	Cr-diopside	55.86	0.16	1.79	0.97	0.09	3.01	0.16	0.08	18.56	18.50	1.37	0.04	100.58	91.7
18048	178	03-MPB-009	0.18-0.25	Cr-diopside	55.69	0.22	1.85	1.02	0.05	3.01	0.11	0.04	18.28	18.52	1.54	0.04	100.36	91.5
18048	179	03-MPB-009	0.18-0.25	Cr-diopside	55.51	0.06	1.32	1.04	0.02	2.54	0.10	0.09	18.44	19.67	1.21	0.07	100.07	92.8
18048	180	03-MPB-009	0.18-0.25	Cr-diopside	55.42	0.11	1.69	1.03	0.15	2.88	0.10	0.03	18.00	19.10	1.42	0.08	100.00	91.8

Appendix C.4 Microprobe data for olivine.

Mount	Grain No.	Sample	Size (mm)	Mineral	SiO_2	TiO_2	Al_2O_3	Cr_2O_3	V_2O_3	FeO_{tot}	MnO	NiO	MgO	CaO	Na_2O	K_2O	TOTAL	Mg-#
18048	96	03-MPB-009	0.18-0.25	olivine	39.96	0.03	0.00	0.01	0.09	8.63	0.12	0.38	47.33	0.04	0.00	0.00	96.59	90.7
18048	134	03-MPB-009	0.18-0.25	olivine	40.40	0.05	0.08	0.01	0.00	7.28	0.13	0.35	48.10	0.02	0.03	0.00	96.43	92.2
18048	181	03-MPB-009	0.25-0.5	olivine	40.85	0.02	0.00	0.02	0.00	7.94	0.07	0.35	50.02	0.04	0.01	0.01	99.33	91.8
18048	182	03-MPB-009	0.25-0.5	olivine	41.15	0.04	0.04	0.01	0.00	7.94	0.07	0.43	49.71	0.05	0.01	0.00	99.46	91.8
18048	183	03-MPB-009	0.25-0.5	olivine	40.99	0.04	0.06	0.06	0.03	9.28	0.14	0.24	49.21	0.02	0.05	0.00	100.13	90.4
18048	184	03-MPB-009	0.25-0.5	olivine	41.64	0.00	0.01	0.06	0.04	7.04	0.14	0.43	50.73	0.00	0.02	0.00	100.12	92.8
18048	185	03-MPB-009	0.25-0.5	olivine	40.44	0.05	0.01	0.11	0.00	9.77	0.13	0.31	47.89	0.00	0.00	0.00	98.70	89.7
18048	186	03-MPB-009	0.25-0.5	olivine	41.38	0.11	0.03	0.09	0.00	7.84	0.15	0.40	50.04	0.04	0.00	0.01	100.10	91.9
18048	187	03-MPB-009	0.25-0.5	olivine	41.24	0.01	0.03	0.06	0.00	8.87	0.09	0.43	49.45	0.01	0.01	0.00	100.20	90.9
18048	188	03-MPB-009	0.25-0.5	olivine	41.11	0.01	0.04	0.08	0.00	9.93	0.05	0.33	48.94	0.02	0.00	0.00	100.50	89.8
18048	189	03-MPB-009	0.25-0.5	olivine	40.31	0.07	0.04	0.04	0.06	8.64	0.15	0.34	48.76	0.00	0.02	0.03	98.47	91.0
18048	190	03-MPB-009	0.25-0.5	olivine	41.06	0.04	0.06	0.03	0.00	8.69	0.05	0.36	49.44	0.02	0.02	0.00	99.75	91.0
18048	191	03-MPB-009	0.25-0.5	olivine	41.10	0.04	0.04	0.05	0.00	8.42	0.13	0.38	49.85	0.02	0.01	0.00	100.03	91.3
18048	192	03-MPB-009	0.25-0.5	olivine	40.95	0.06	0.01	0.14	0.00	8.01	0.19	0.36	49.58	0.00	0.03	0.00	99.32	91.7
18048	193	03-MPB-009	0.25-0.5	olivine	41.12	0.05	0.00	0.09	0.00	7.39	0.11	0.39	50.69	0.00	0.02	0.00	99.85	92.4
18048	194	03-MPB-009	0.25-0.5	olivine	41.41	0.05	0.00	0.06	0.00	8.49	0.12	0.30	49.43	0.04	0.01	0.00	99.89	91.2
18048	195	03-MPB-009	0.25-0.5	olivine	40.72	0.04	0.01	0.05	0.00	8.91	0.12	0.36	49.02	0.01	0.03	0.00	99.27	90.7
18048	196	03-MPB-009	0.25-0.5	olivine	40.85	0.01	0.05	0.11	0.02	8.37	0.05	0.36	49.61	0.04	0.00	0.02	99.49	91.4
18048	197	03-MPB-009	0.25-0.5	olivine	40.75	0.05	0.04	0.00	0.00	9.59	0.07	0.33	48.51	0.05	0.00	0.00	99.37	90.0
18048	198	03-MPB-009	0.25-0.5	olivine	41.28	0.01	0.07	0.07	0.01	6.98	0.11	0.44	50.74	0.03	0.00	0.00	99.74	92.8
18048	199	03-MPB-009	0.25-0.5	olivine	41.34	0.00	0.00	0.08	0.00	7.73	0.09	0.45	50.33	0.00	0.02	0.00	100.04	92.1
18048	200	03-MPB-009	0.25-0.5	olivine	41.25	0.00	0.02	0.05	0.05	8.30	0.15	0.36	49.67	0.03	0.03	0.01	99.93	91.4
18048	201	03-MPB-009	0.25-0.5	olivine	40.86	0.04	0.08	0.04	0.00	8.93	0.08	0.38	48.99	0.05	0.02	0.00	99.47	90.7
18048	202	03-MPB-009	0.25-0.5	olivine	40.52	0.03	0.04	0.05	0.00	10.37	0.08	0.39	48.32	0.06	0.01	0.00	99.87	89.3
18048	203	03-MPB-009	0.25-0.5	olivine	40.52	0.07	0.01	0.06	0.00	9.33	0.05	0.37	48.96	0.06	0.05	0.01	99.50	90.3
18048	204	03-MPB-009	0.25-0.5	olivine	40.57	0.06	0.03	0.04	0.00	8.25	0.13	0.31	49.99	0.02	0.02	0.03	99.45	91.5
18048	205	03-MPB-009	0.25-0.5	olivine	41.37	0.02	0.04	0.02	0.00	8.52	0.07	0.36	49.45	0.00	0.05	0.00	99.90	91.2
18048	206	03-MPB-009	0.25-0.5	olivine	40.62	0.00	0.04	0.06	0.05	8.58	0.14	0.36	49.34	0.03	0.04	0.03	99.30	91.1
18048	207	03-MPB-009	0.25-0.5	olivine	40.94	0.00	0.05	0.08	0.00	7.29	0.12	0.35	50.40	0.01	0.02	0.00	99.26	92.5
18048	208	03-MPB-009	0.25-0.5	olivine	40.56	0.00	0.00	0.00	0.00	8.47	0.15	0.49	49.76	0.03	0.02	0.00	99.47	91.3
18048	209	03-MPB-009	0.25-0.5	olivine	40.60	0.04	0.07	0.04	0.07	8.70	0.13	0.40	49.04	0.07	0.01	0.00	99.17	91.0
18048	210	03-MPB-009	0.25-0.5	olivine	40.31	0.04	0.06	0.06	0.00	8.65	0.11	0.38	49.07	0.05	0.04	0.00	98.76	91.0
18048	211	03-MPB-009	0.25-0.5	olivine	40.58	0.02	0.03	0.10	0.03	9.12	0.10	0.27	49.34	0.03	0.04	0.00	99.66	90.6
18048	212	03-MPB-009	0.25-0.5	olivine	40.59	0.01	0.06	0.02	0.00	8.44	0.10	0.45	49.21	0.02	0.00	0.00	98.90	91.2
18048	213	03-MPB-009	0.25-0.5	olivine	41.08	0.02	0.04	0.02	0.00	8.04	0.08	0.31	49.68	0.04	0.07	0.00	99.39	91.7
18048	214	03-MPB-009	0.25-0.5	olivine	40.65	0.01	0.00	0.03	0.00	7.93	0.13	0.35	50.45	0.00	0.01	0.02	99.59	91.9

Appendix C.4 continued.

Mount	Grain No.	Sample	Size (mm)	Mineral	SiO_2	TiO_2	Al_2O_3	Cr_2O_3	V_2O_3	FeO_{tot}	MnO	NiO	MgO	CaO	Na_2O	K_2O	TOTAL	Mg-#
18048	215	03-MPB-009	0.25-0.5	olivine	40.94	0.05	0.05	0.08	0.01	7.71	0.14	0.37	50.10	0.00	0.04	0.00	99.47	92.1
18048	216	03-MPB-009	0.25-0.5	olivine	40.41	0.03	0.00	0.08	0.00	8.00	0.11	0.43	49.94	0.03	0.00	0.00	99.02	91.8
18048	217	03-MPB-009	0.25-0.5	olivine	41.12	0.06	0.03	0.06	0.00	8.22	0.17	0.40	50.02	0.00	0.01	0.00	100.07	91.6
18048	218	03-MPB-009	0.25-0.5	olivine	40.77	0.03	0.00	0.17	0.09	8.69	0.09	0.46	49.53	0.02	0.03	0.00	99.88	91.0
18048	219	03-MPB-009	0.25-0.5	olivine	40.78	0.00	0.05	0.10	0.00	8.35	0.16	0.37	49.57	0.02	0.02	0.03	99.45	91.4
18048	220	03-MPB-009	0.25-0.5	olivine	41.07	0.01	0.03	0.01	0.00	7.99	0.12	0.49	50.02	0.02	0.01	0.00	99.78	91.8
18048	221	03-MPB-009	0.25-0.5	olivine	40.12	0.10	0.04	0.00	0.00	10.94	0.12	0.29	47.65	0.04	0.03	0.00	99.33	88.6
18048	222	03-MPB-009	0.25-0.5	olivine	40.31	0.00	0.04	0.02	0.02	8.86	0.13	0.32	48.89	0.00	0.02	0.00	98.62	90.8
18048	223	03-MPB-009	0.25-0.5	olivine	40.56	0.07	0.02	0.04	0.00	9.44	0.14	0.38	48.75	0.05	0.00	0.00	99.45	90.2
18048	224	03-MPB-009	0.25-0.5	olivine	40.78	0.01	0.03	0.07	0.04	7.94	0.11	0.39	50.20	0.00	0.01	0.01	99.60	91.9
18048	225	03-MPB-009	0.25-0.5	olivine	40.74	0.07	0.03	0.00	0.05	8.58	0.14	0.40	49.59	0.08	0.01	0.00	99.71	91.2
18048	226	03-MPB-009	0.25-0.5	olivine	40.46	0.02	0.03	0.01	0.03	8.62	0.09	0.47	48.82	0.00	0.00	0.00	98.56	91.0
18048	227	03-MPB-009	0.25-0.5	olivine	40.84	0.04	0.06	0.00	0.00	8.37	0.11	0.34	49.24	0.03	0.02	0.00	99.06	91.3
18048	228	03-MPB-009	0.25-0.5	olivine	40.78	0.02	0.00	0.00	0.06	7.47	0.12	0.40	50.16	0.02	0.01	0.00	99.04	92.3
18048	229	03-MPB-009	0.25-0.5	olivine	41.20	0.00	0.03	0.06	0.00	7.66	0.12	0.35	49.79	0.01	0.00	0.00	99.21	92.1
18048	230	03-MPB-009	0.25-0.5	olivine	41.14	0.05	0.00	0.02	0.00	9.03	0.17	0.33	49.75	0.03	0.00	0.00	100.53	90.8
18048	231	03-MPB-009	0.25-0.5	olivine	40.97	0.05	0.05	0.12	0.02	7.89	0.09	0.44	50.21	0.04	0.03	0.00	99.92	91.9
18048	232	03-MPB-009	0.25-0.5	olivine	41.11	0.05	0.08	0.08	0.02	7.70	0.10	0.44	50.24	0.09	0.07	0.01	99.98	92.1
18048	233	03-MPB-009	0.25-0.5	olivine	40.53	0.03	0.01	0.08	0.04	9.31	0.03	0.35	48.74	0.02	0.01	0.00	99.15	90.3
18048	234	03-MPB-009	0.25-0.5	olivine	40.78	0.04	0.07	0.08	0.00	8.96	0.17	0.33	48.63	0.03	0.06	0.00	99.16	90.6
18048	235	03-MPB-009	0.25-0.5	olivine	40.50	0.03	0.04	0.12	0.00	9.39	0.10	0.37	48.84	0.03	0.00	0.02	99.44	90.3
18048	236	03-MPB-009	0.25-0.5	olivine	40.64	0.01	0.01	0.06	0.00	8.51	0.09	0.33	49.69	0.00	0.02	0.00	99.36	91.2
18048	237	03-MPB-009	0.25-0.5	olivine	41.17	0.07	0.02	0.04	0.00	8.04	0.08	0.39	49.98	0.00	0.00	0.00	99.79	91.7
18048	238	03-MPB-009	0.25-0.5	olivine	41.05	0.04	0.04	0.00	0.05	8.42	0.08	0.38	49.57	0.04	0.01	0.00	99.70	91.3
18048	239	03-MPB-009	0.25-0.5	olivine	41.11	0.04	0.04	0.04	0.02	6.92	0.18	0.33	50.80	0.00	0.05	0.00	99.52	92.9
18048	240	03-MPB-009	0.25-0.5	olivine	41.44	0.00	0.02	0.04	0.00	7.48	0.13	0.36	50.55	0.02	0.01	0.01	100.08	92.3
18048	241	03-MPB-009	0.25-0.5	olivine	40.77	0.02	0.01	0.15	0.00	9.06	0.14	0.40	49.17	0.00	0.04	0.00	99.76	90.6
18048	242	03-MPB-009	0.25-0.5	olivine	41.10	0.04	0.01	0.07	0.05	7.71	0.16	0.38	50.65	0.06	0.01	0.02	100.26	92.1
18048	243	03-MPB-009	0.25-0.5	olivine	40.69	0.09	0.06	0.11	0.00	8.59	0.06	0.35	49.29	0.11	0.06	0.01	99.44	91.1
18048	244	03-MPB-009	0.25-0.5	olivine	41.08	0.02	0.05	0.05	0.00	7.67	0.09	0.39	50.21	0.00	0.00	0.01	99.57	92.1
18048	245	03-MPB-009	0.25-0.5	olivine	40.99	0.00	0.04	0.00	0.00	8.55	0.07	0.35	49.51	0.05	0.01	0.00	99.59	91.2
18048	246	03-MPB-009	0.25-0.5	olivine	40.83	0.08	0.07	0.06	0.01	7.74	0.12	0.33	50.75	0.00	0.01	0.02	100.03	92.1
18048	247	03-MPB-009	0.25-0.5	olivine	40.27	0.05	0.06	0.12	0.02	9.41	0.15	0.41	48.82	0.04	0.04	0.01	99.40	90.2
18048	248	03-MPB-009	0.25-0.5	olivine	40.64	0.05	0.06	0.00	0.00	9.44	0.05	0.37	48.64	0.05	0.03	0.00	99.33	90.2
18048	249	03-MPB-009	0.25-0.5	olivine	41.13	0.01	0.03	0.09	0.03	7.40	0.10	0.41	50.49	0.00	0.01	0.00	99.69	92.4
18048	250	03-MPB-009	0.25-0.5	olivine	40.89	0.01	0.00	0.03	0.00	8.45	0.10	0.47	49.80	0.03	0.00	0.00	99.79	91.3
18048	251	03-MPB-009	0.25-0.5	olivine	40.87	0.04	0.01	0.04	0.00	7.14	0.13	0.35	50.57	0.05	0.01	0.01	99.22	92.7
18048	252	03-MPB-009	0.25-0.5	olivine	40.97	0.02	0.06	0.07	0.04	8.36	0.09	0.38	49.34	0.00	0.00	0.00	99.34	91.3
18048	253	03-MPB-009	0.25-0.5	olivine	40.95	0.00	0.03	0.00	0.00	8.74	0.12	0.42	49.33	0.04	0.02	0.00	99.66	91.0
18048	254	03-MPB-009	0.25-0.5	olivine	40.93	0.03	0.00	0.03	0.05	8.24	0.19	0.43	49.26	0.03	0.00	0.00	99.17	91.4
18048	255	03-MPB-009	0.25-0.5	olivine	40.93	0.00	0.05	0.00	0.00	7.70	0.07	0.52	49.95	0.01	0.00	0.00	99.23	92.0
18048	256	03-MPB-009	0.25-0.5	olivine	40.83	0.05	0.05	0.00	0.02	8.20	0.12	0.34	49.74	0.00	0.00	0.00	99.35	91.5
18048	257	03-MPB-009	0.25-0.5	olivine	40.56	0.03	0.06	0.12	0.01	8.91	0.09	0.37	49.32	0.00	0.03	0.00	99.50	90.8
18048	258	03-MPB-009	0.25-0.5	olivine	40.80	0.03	0.03	0.04	0.01	8.60	0.15	0.34	49.73	0.00	0.00	0.00	99.74	91.2
18048	259	03-MPB-009	0.25-0.5	olivine	41.35	0.07	0.06	0.00	0.04	8.29	0.07	0.35	49.53	0.03	0.00	0.00	99.79	91.4
18048	260	03-MPB-009	0.25-0.5	olivine	40.84	0.05	0.00	0.07	0.02	8.09	0.14	0.31	49.81	0.05	0.01	0.00	99.39	91.7
18048	261	03-MPB-009	0.25-0.5	olivine	40.84	0.03	0.07	0.04	0.09	9.13	0.05	0.29	49.53	0.03	0.03	0.02	100.15	90.6
18048	262	03-MPB-009	0.25-0.5	olivine	40.53	0.02	0.03	0.14	0.03	8.03	0.18	0.43	49.62	0.04	0.03	0.00	99.08	91.7

Appendix C.4 continued.

Mount	Grain No.	Sample	Size (mm)	Mineral	SiO_2	TiO_2	Al_2O_3	Cr_2O_3	V_2O_3	FeO_{tot}	MnO	NiO	MgO	CaO	Na_2O	K_2O	TOTAL	Mg-#
18048	261	03-MPB-009	0.25-0.5	olivine	40.84	0.03	0.07	0.04	0.09	9.13	0.05	0.29	49.53	0.03	0.03	0.02	100.15	90.6
18048	262	03-MPB-009	0.25-0.5	olivine	40.53	0.02	0.03	0.14	0.03	8.03	0.18	0.43	49.62	0.04	0.03	0.00	99.08	91.7
18048	263	03-MPB-009	0.25-0.5	olivine	40.97	0.05	0.03	0.06	0.02	8.48	0.12	0.34	49.66	0.03	0.05	0.00	99.82	91.3
18048	264	03-MPB-009	0.25-0.5	olivine	40.69	0.05	0.01	0.05	0.04	8.07	0.16	0.43	49.94	0.00	0.00	0.00	99.45	91.7
18048	265	03-MPB-009	0.25-0.5	olivine	41.41	0.05	0.03	0.00	0.02	8.02	0.10	0.40	49.84	0.02	0.03	0.00	99.92	91.7
18048	266	03-MPB-009	0.25-0.5	olivine	41.08	0.00	0.07	0.08	0.05	7.92	0.13	0.36	49.96	0.03	0.00	0.00	99.69	91.8
18048	267	03-MPB-009	0.25-0.5	olivine	40.54	0.03	0.03	0.00	0.09	9.54	0.15	0.43	48.49	0.04	0.01	0.00	99.37	90.1
18048	268	03-MPB-009	0.25-0.5	olivine	40.37	0.10	0.00	0.01	0.00	9.48	0.13	0.31	48.60	0.02	0.01	0.00	99.05	90.1
18048	269	03-MPB-009	0.25-0.5	olivine	40.65	0.04	0.05	0.07	0.01	8.78	0.13	0.33	49.38	0.05	0.00	0.00	99.49	90.9
18048	270	03-MPB-009	0.25-0.5	olivine	40.65	0.04	0.03	0.02	0.00	8.72	0.08	0.37	49.30	0.02	0.03	0.01	99.27	91.0

Appendix C.5 Microprobe data for chromian corundum.

Mount	Grain No.	Sample	Size (mm)	Mineral	SiO_2	TiO_2	Al_2O_3	Cr_2O_3	V_2O_3	FeO_{tot}	MnO	NiO	MgO	CaO	Na_2O	K_2O	TOTAL	Comment
18048	4	03-MPB-009	0.25-0.5	ruby	0.04	0.05	91.91	6.52	0.06	0.35	0.02	0.00	0.00	0.00	0.00	0.01	98.96	picked as Cr-pyrope
18048	6	03-MPB-009	0.25-0.5	ruby	0.03	0.00	92.87	6.21	0.05	0.28	0.03	0.00	0.00	0.00	0.00	0.00	99.46	picked as Cr-pyrope
18048	7	03-MPB-009	0.25-0.5	ruby	0.03	0.03	92.86	6.11	0.01	0.39	0.00	0.00	0.01	0.00	0.00	0.01	99.44	picked as Cr-pyrope
18048	12	03-MPB-009	0.25-0.5	ruby	0.07	0.00	92.50	6.04	0.03	0.29	0.00	0.03	0.00	0.00	0.00	0.00	98.97	picked as Cr-pyrope
18048	14	03-MPB-009	0.25-0.5	ruby	0.07	0.09	92.39	6.01	0.01	0.45	0.07	0.04	0.03	0.00	0.01	0.00	99.16	picked as Cr-pyrope
18048	15	03-MPB-009	0.25-0.5	ruby	0.07	0.05	92.98	6.00	0.00	0.26	0.00	0.00	0.00	0.02	0.00	0.00	99.39	picked as Cr-pyrope
18048	16	03-MPB-009	0.25-0.5	ruby	0.01	0.04	93.01	6.67	0.09	0.22	0.00	0.00	0.00	0.00	0.00	0.00	100.04	picked as Cr-pyrope
18048	17	03-MPB-009	0.25-0.5	ruby	0.05	0.09	92.24	6.36	0.00	0.38	0.00	0.00	0.05	0.00	0.00	0.00	99.17	picked as Cr-pyrope
18048	25	03-MPB-009	0.18-0.25	ruby	0.10	0.00	95.85	3.22	0.04	0.38	0.00	0.08	0.00	0.00	0.04	0.00	99.69	picked as Cr-pyrope
18048	40	03-MPB-009	0.18-0.25	ruby	0.05	0.07	92.96	5.83	0.08	0.35	0.00	0.06	0.00	0.00	0.00	0.01	99.40	picked as Cr-pyrope
18048	42	03-MPB-009	0.18-0.25	ruby	0.04	0.00	95.25	3.55	0.00	0.37	0.00	0.04	0.00	0.00	0.03	0.00	99.25	picked as Cr-pyrope
18048	43	03-MPB-009	0.18-0.25	ruby	0.07	0.05	92.44	6.19	0.08	0.45	0.05	0.00	0.03	0.00	0.01	0.00	99.36	picked as Cr-pyrope
18048	48	03-MPB-009	0.18-0.25	ruby	0.02	0.08	92.88	6.33	0.04	0.40	0.00	0.07	0.02	0.00	0.03	0.00	99.84	picked as Cr-pyrope