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Mineralogy and geochemistry of till and soil
overlying the Buffonta kimberlite dike,
Kirkland Lake, Ontario

M.B. McClenaghan, I.M. Kjarsgaard, D. Crabtree, R.N.W. DiLabio

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INTRODUCTION

In 1992, the Geological Survey of Canada began a four- year project to investigate kimberlites in the Kirkland Lake, Ontario area. Part of this project included the study of the geochemical and mineralogical character of known kimberlitic intrusions and their associated mineralogical and geochemical signatures in various sample media routinely used in mineral exploration (e.g. drift, soil and vegetation).

Most bedrock in the Kirkland Lake area is covered by glacial sediments, from a few metres to 100 m thick. By applying a combination of drift prospecting and geophysical methods, several kimberlite pipes and dikes (Fig. 1) have been discovered in the region within the last 10 years (Brummer et al., 1992a; McClenaghan, 1993; Sage, 1994). The Buffonta kimberlite dike was examined to determine the geochemical and glacial dispersal patterns associated with a small linear kimberlite source as compared to the patterns from larger, circular kimberlite pipes. Gold distribution patterns on the Buffonta property were examined as well because the property has a long history of gold exploration. This report describes the mineralogical and geochemical characteristics of the Buffonta kimberlite dike as well as soil, vegetation and till mineralogy and geochemistry overlying the dike. Results on the geochemistry of vegetation have been published in a separate report (McClenaghan and Dunn, 1995), and are summarized here.

Location and Access

The Kirkland Lake kimberlite field is in northeastern Ontario, 10 km to the north and east of Kirkland Lake and 100 km southeast of Timmins (Fig. 1). The Buffonta property is located at 48°28'N and 79°56' W, (UTM 577000, 5369800) in south-central Garrison Township, 35 km north of Kirkland Lake. The property is reached from the northwest by a gravel road which joins Highway 101 near Perry Lake. Two open pits have been excavated on the property (Fig. 2), the first was excavated in 1981 and is referred to as the old Buffonta pit. The kimberlite

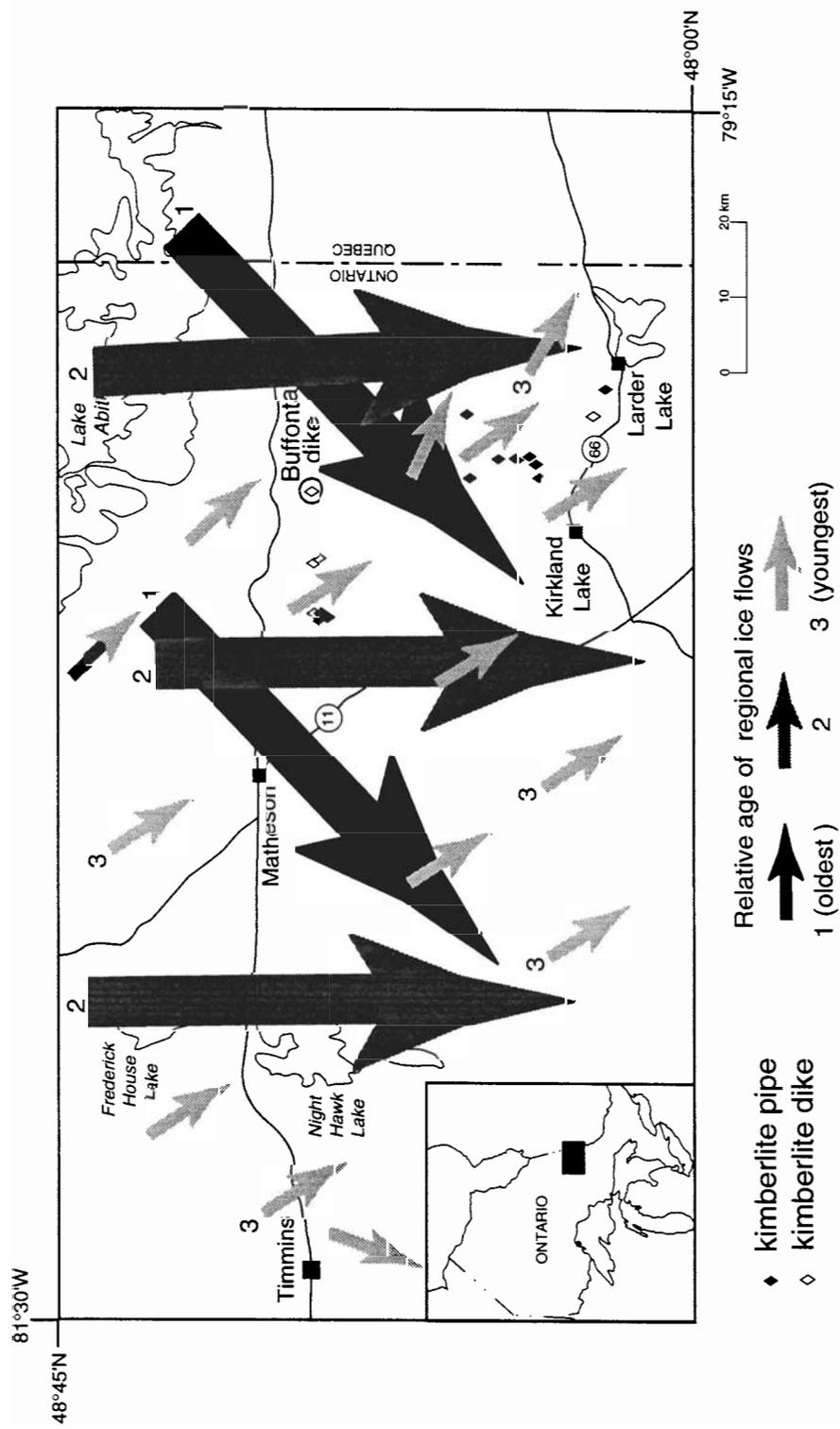


Figure 1. Location of the study area, the Buffonta dike and other kimberlite occurrences and regional ice flow patterns (modified from McClenaghan et al., 1995).

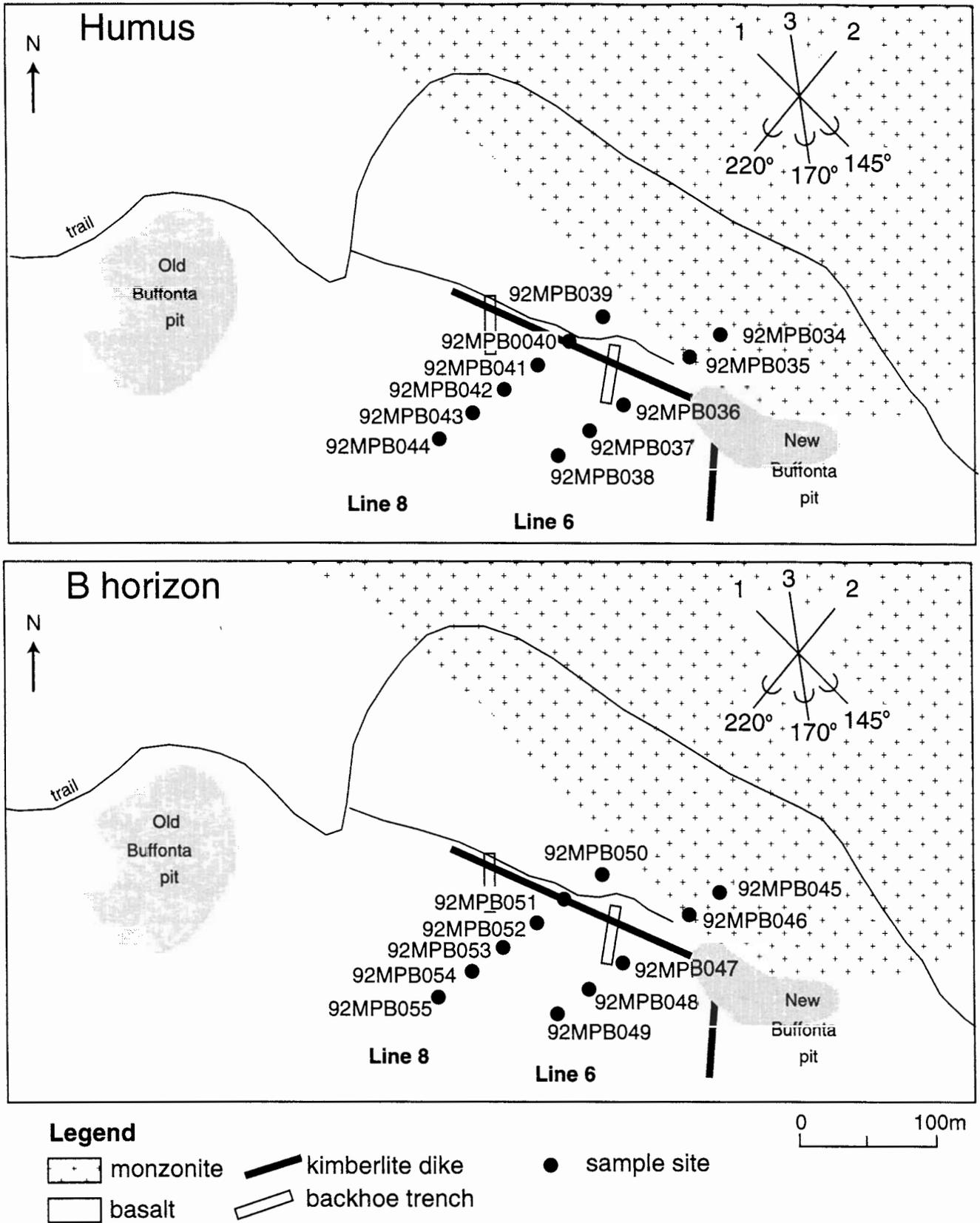


Figure 2. Buffonta property map, locations of humus and B horizon soil sample sites, bedrock geology and local ice flow history.

dike is exposed in the walls of a second, smaller open pit, located 350 m southeast of the first pit, that was excavated in 1990-91.

Geology

The Buffonta property is in the western part of the Archean Abitibi Greenstone Belt and is underlain by mafic metavolcanic rocks (Fig. 2) and the Garrison monzonite stock (Jensen, 1982; Bath, 1990). Gold mineralization was first discovered on the Buffonta property 75 years ago (Satterly, 1949) and it has been explored and mined intermittently ever since. Bedrock in the area was mapped by Satterly (1949) and Jensen (1982). Cherry (1983) and Carrigan (1984), who studied the gold mineralization and alteration on this property, reported that gold mineralization, with galena, argentite and chalcopyrite, occurs in quartz veins that have intruded foliated volcanic rocks within a 1 km wide contact metamorphic aureole around the Garrison Stock.

Kimberlite on the Buffonta property was first reported by Gajaria (1987; in Bath, 1990) from intersections in diamond drill holes. In 1991, a kimberlite dike was exposed (Photo 1) during the excavation of the new Buffonta pit. Barron and Barnett (1993) confirmed the kimberlitic nature of the dike by geochemical and mineralogical analyses. The dike intrudes mafic volcanic rocks within the mineralized metamorphic aureole around the Garrison Stock. It has intruded along near-vertical shear zones, strikes westward and southward from the new pit (Fig. 2) and is approximately 1.0 m wide. The kimberlite dike is a kimberlite breccia comprising fragments of angular vein quartz and pyritized felsic intrusive rocks within a kimberlite matrix (Barron and Barnett, 1993). On the west side of the new pit, the dike has intruded along the edge of a 0.4 m wide quartz vein (Photo 2). The subcropping surface of the kimberlite dike is weathered sufficiently that it can be excavated easily with a hand shovel. Kimberlitic intrusions in the Kirkland Lake region were emplaced approximately 155 to 160 Ma (Brummer et al., 1992b) and the Buffonta dike is of similar age (L. Heaman, personal communication, 1995).



Photo 1. Kimberlite dike exposed in the west end of the new Buffonta pit (GSC Photo 1994-496).



Photo 2. Weathered kimberlite dike (sample 92MPB339) and adjacent quartz vein overlain by till in the east wall of trench B (GSC photo 1994-495C).

Surficial geology of the region was mapped by Baker et al. (1982) at a scale of 1:50 000. On the Buffonta property, bedrock is covered by a continuous layer of Matheson Till up to 3 m thick. Regional ice flow directions associated with Matheson Till are summarized in Figure 1. Ice flow shifted from southwest during the main phase of the last (Wisconsinan) to southeast during deglaciation in the Late Wisconsinan. Striations trending in three different directions were found around the western end of new Buffonta pit and at the south end of trenches A and B; these are summarized in Figure 2. The oldest southeast (145°) trending striations may be the result of localized ice flow channeled along the kimberlite dike. Subsequent ice flow striated the bedrock towards the southwest (240°) and is crossed by the youngest striations which trend southwards.

METHODS

Sample Collection

Vegetation, soil, till and kimberlite samples were collected from the Buffonta property in the summer and fall of 1992. Soil samples were collected from 12 sites, 30 m apart, along two existing cut lines, referred to as Line 6 and Line 8 by the current property holders, oriented northeast-southwest (Figs. 2 and 3). At each site, samples of humus, B and C horizon material (developed on till) were collected from a hand-dug hole, 0.7 to 1.0 m deep. Each site was photographed and described. Balsam fir and pin cherry twigs were collected at the same 12 sites on lines 6 and 8 and those sampling methods are described in detail by McClenaghan and Dunn (1995).

Fifty 7 to 10 kg till samples (samples 92MPB300 to 356) were collected from two backhoe trenches dug north to south across the kimberlite dike, 200 m to the west of the new Buffonta pit (Figs. 3 and 4). Five till samples (samples 92MPB001 to 005) were collected from stripped outcrop around the western edge of the new pit. Samples 92MPB001 and 92MPB002 were collected from material overlying the kimberlite dike. Samples 92MPB003 and 92MPB004 were collected 25 m and 40 m, respectively, south of the dike. Sample 92MPB005 was collected 25 m

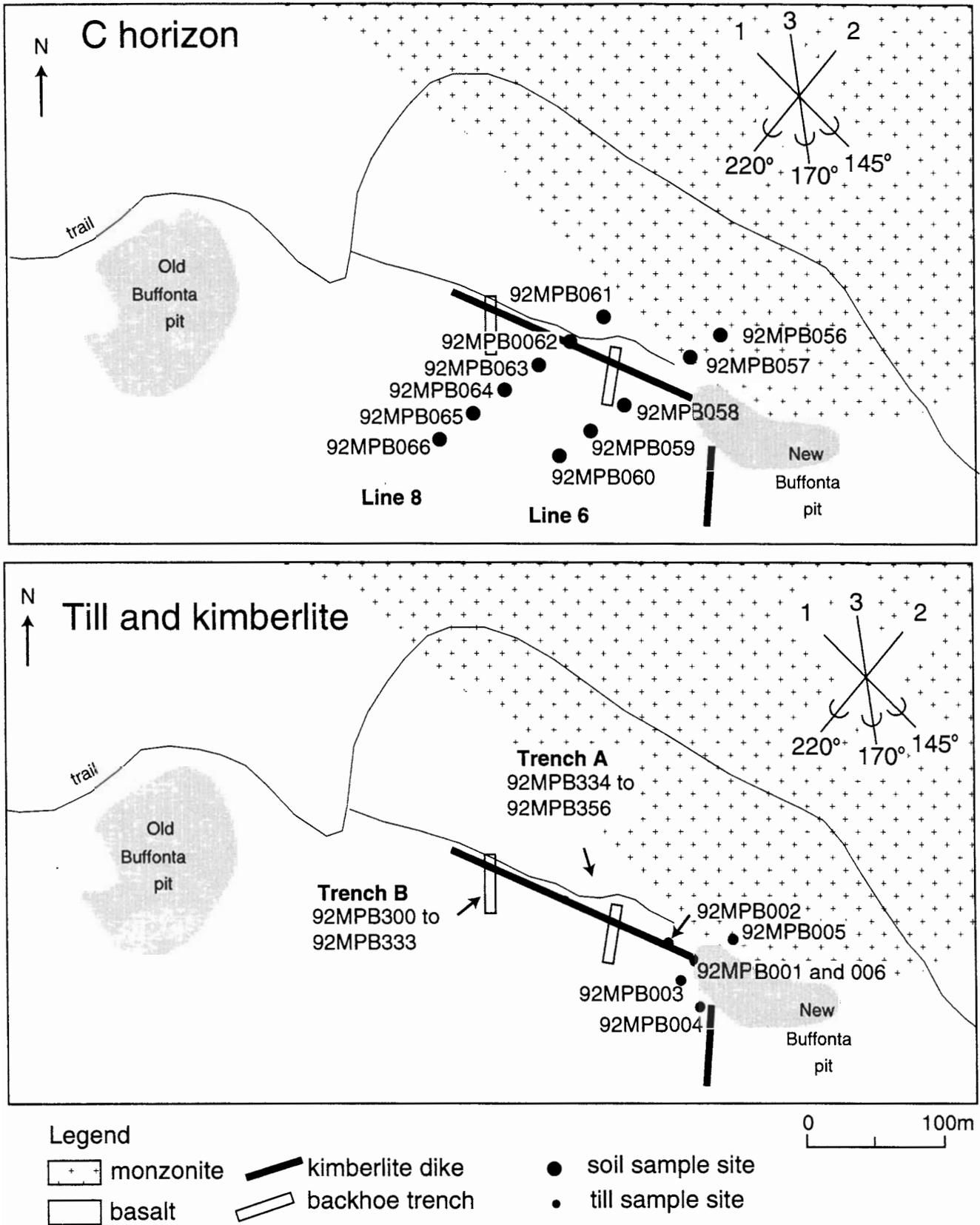


Figure 3. Buffonta property map and locations of C horizon soil, till and kimberlite samples sites

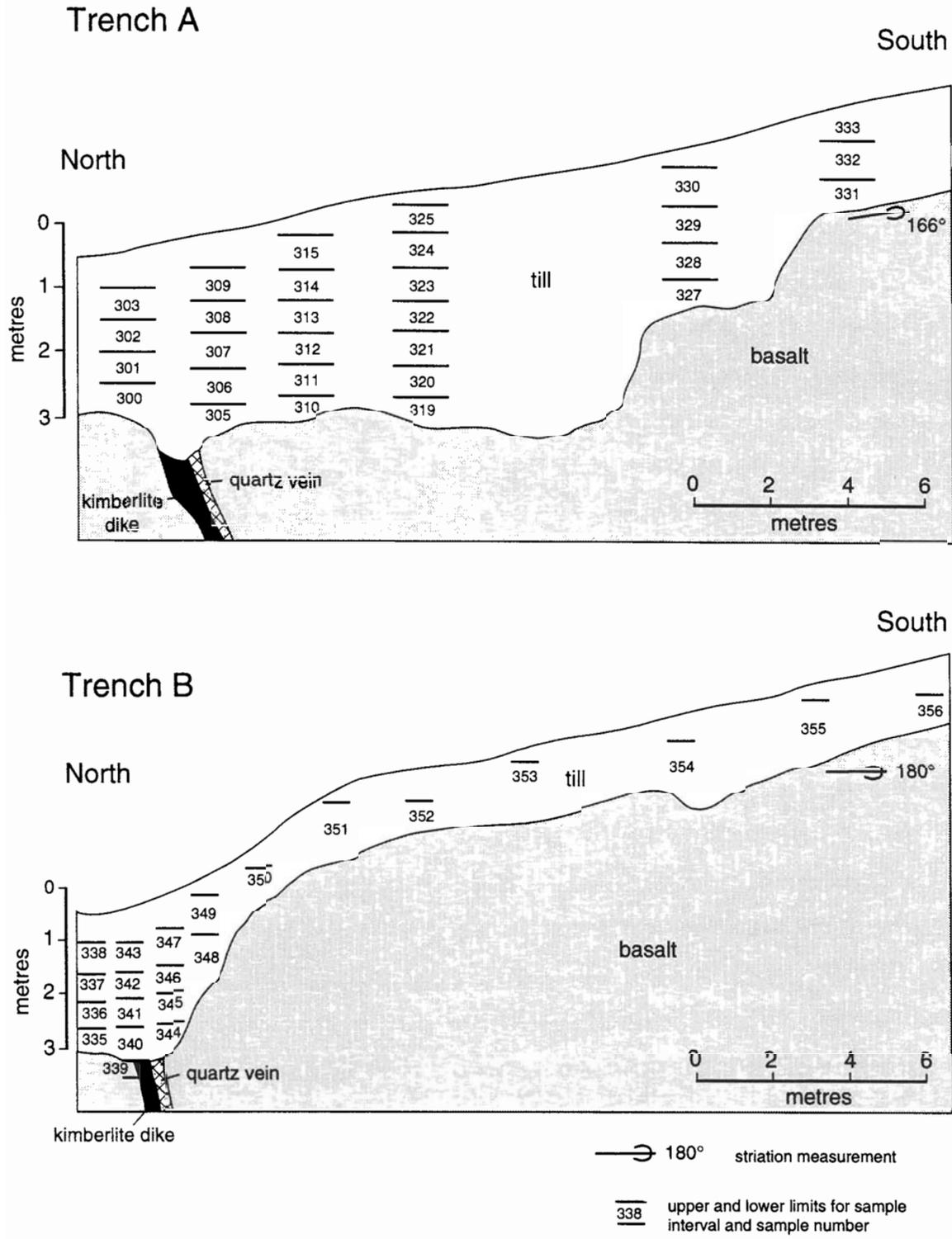


Figure 4. Till sample locations and striae data from trenches A and B.

northeast of the dike (Fig. 3). Sample site descriptions and location information are listed in Appendix A.

Two 5 kg bulk samples of weathered kimberlite dike were collected; 1) samples 92MPB006 was collected from the stripped outcrop at the western edge of the new pit underlying sample site 92MPB001; and 2) sample 92MPB339 was collected from the bottom of trench B, underlying 2.5 m of till.

Sample Processing

Till and kimberlite samples were processed by Overburden Drilling Management Ltd., Nepean, Ontario to recover a heavy mineral concentrate for examination of kimberlite indicator minerals and gold grains, as outlined in Figure 5. Weights for most fractions produced during the processing procedure are reported in Appendix B. First, the > 2 mm (+10 mesh) material was screened off the samples and put aside for pebble lithology classification. Samples were further screened to obtain two fractions, the 1.0 to 2.0 mm fraction and <1.0 mm fraction, that were processed separately to produce two fractions for picking of kimberlite indicator minerals.

The 1.0 to 2.0 mm fraction was not put across the shaking table because of the risk of significant losses of coarse heavy minerals. Instead, this fraction was put directly through methylene iodide diluted with acetone to a specific gravity (S.G.) of 3.2 to separate the light and heavy mineral fractions. The methylene iodide was diluted from full strength (S.G. 3.3) to maximize the recovery of chrome diopside (S.G. ≥ 3.2), the mineral with the lowest specific gravity of the five kimberlite indicator minerals. The light minerals (< 3.2 S.G.) were removed and put aside for future reference. The heavy minerals (> 3.2 S.G.) were further refined by removing the ferromagnetic minerals using a hand magnet, to produce a 1.0 to 2.0 mm non-ferromagnetic heavy mineral fraction for picking.

The <1.0 mm fraction was processed using a combination of tabling and heavy liquid separation. First, the <1.0 mm material was passed over a shaking table twice to obtain a preconcentrate, which was then panned to recover gold and sulphide grains. The gold grains were counted, described and returned to

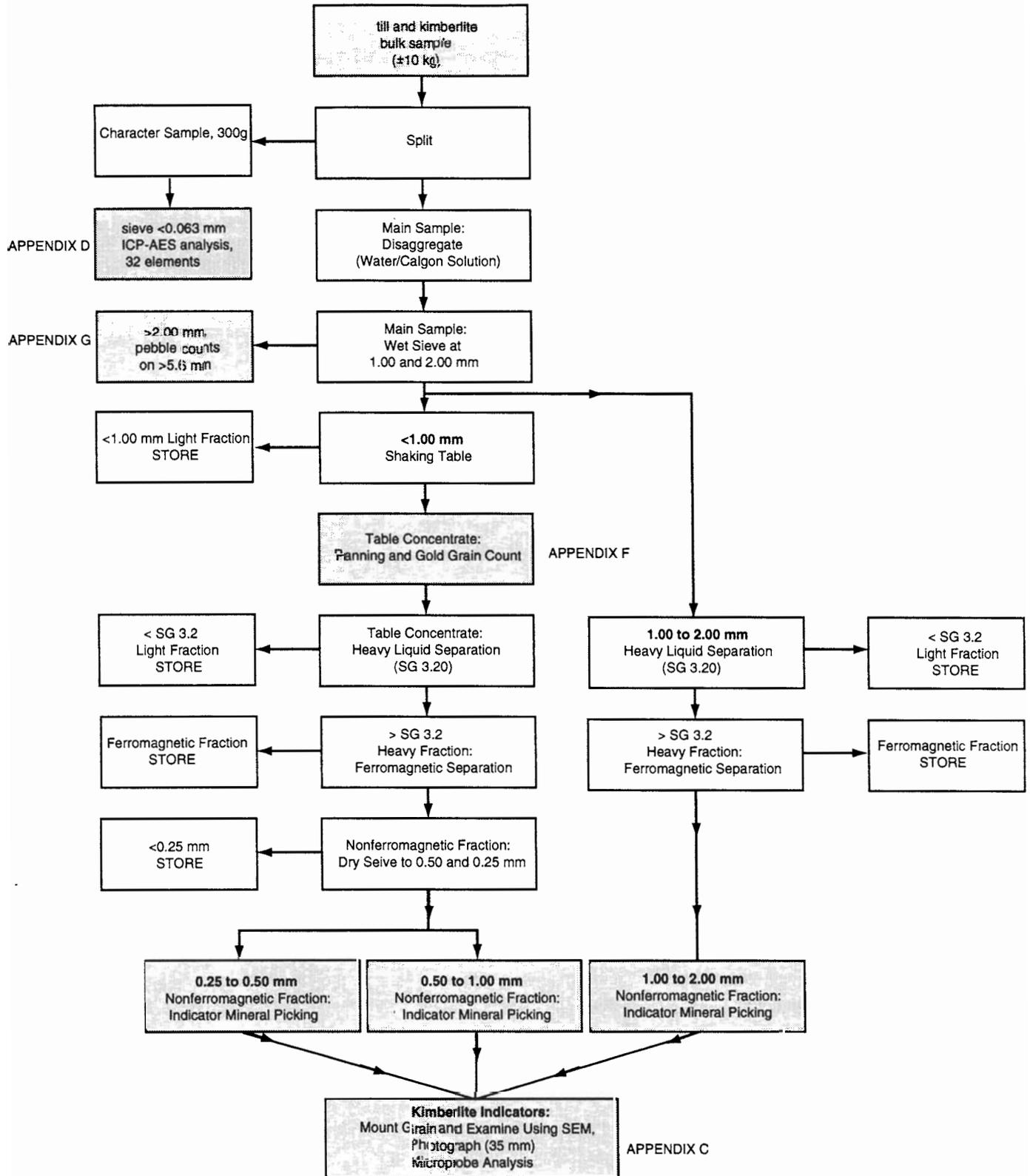


Figure 5 - Sample processing flow sheet for recovery of kimberlite indicator minerals and gold grains from till and weathered kimberlite.

the sample. The presence or absence of any sulphide grains with the gold grains was noted. The preconcentrate was then further refined using heavy liquid separation as described above to produce a heavy mineral fraction (S.G.>3.2). The ferromagnetic heavy minerals were removed using a hand magnet, leaving the <1.0 mm non-ferromagnetic heavy mineral fraction for indicator mineral picking. This combination of tabling and heavy liquid separation was used to recover indicator minerals because tabling also recovers gold grains that can be examined and counted. Gold grain counts are important extra information when exploring for diamonds in gold-bearing areas such as Kirkland Lake.

The 1.0 to 2.0 mm and the <1.0 mm non-ferromagnetic fractions were sent to Lakefield Research, Lakefield, Ontario for indicator mineral picking and mounting. The <1.0 mm fraction was sieved into three fractions and the finest material, the <0.25 mm (-60 mesh), was set aside. The other two sieved fractions, 0.25-0.5 mm and the 0.5-1.0 mm, along with the prepared 1.0-2.0 mm fraction were then examined using a binocular microscope and potential kimberlite indicator minerals were picked out. Potential indicator minerals were identified on the basis of visual properties, such as colour and grain morphology. Minerals picked included Cr- pyrope (purple), titanian pyrope (orange-red to purple), Cr diopside (pale to emerald green), Mg ilmenite (metallic black), and chromite (Cr spinel; black). Potential indicator minerals were mounted in 25 mm epoxy mounts and polished in preparation for electron microprobe analysis to confirm their identity.

Kimberlite Indicator Mineral Identification

Potential kimberlite indicator mineral grains recovered from till and kimberlite samples were analyzed using the electron microprobe facilities of the Ontario Geological Survey (samples 92MPB300 to 356) and the Geological Survey of Canada (samples 92MPB001 to 006, and 339). Microprobe operating conditions were similar to those described by McClenaghan et al. (1993). A complete listing of all major oxide analyses, mineral names, colour and size range for the 1116 potential kimberlite indicator minerals are listed in Appendix C.1. Appendixes

C.2 to C.4 contain microprobe data organized according to indicator mineral species.

Minerals were identified and named using similar criteria to those of McClenaghan et al. (1993) and are outlined below. Ilmenites with ≥ 6 wt.% MgO were classified as kimberlitic Mg ilmenites. Cr pyrope was identified by its pink to purple colour, its high MgO content (≥ 16 wt.%) as well as several wt.% Cr₂O₃. Diamond inclusion (DI) chromite (Cr spinels) contain >62 wt.% Cr₂O₃ and 12 to 17 wt.% MgO. Diopside grains containing ≥ 1.0 wt.% Cr₂O₃ were classified as kimberlitic Cr diopside. This minimum value was used instead of 0.5% wt.% Cr₂O₃ used by Fipke (1989) and Thorleifson et al. (1994) to exclude Cr-rich diopsides from other basic and ultrabasic rocks. Other minerals were identified by comparing wt. % oxides to published analyses.

No formula calculation was applied to the mineral analyses to confirm identification, and therefore, no end-member calculations are available for garnets, spinels or pyroxenes. Prefixes such as Mg-, Ti-, and Cr- were added to mineral names to point out compositional features which are important in distinguishing between potential kimberlite minerals and those from other sources. Readers are encouraged to examine the indicator mineral data in Appendix C and reclassify indicator minerals using their own criteria.

Geochemical Analysis

Soil, till and kimberlite samples were prepared at Bondar-Clegg and Company Ltd., Ottawa, Ontario, prior to geochemical analysis. Humus samples were oven-dried and sieved to <0.42 mm (-40 mesh). The B and C horizon soil samples and a 300 g split (Fig. 5) of the bulk till and kimberlite samples were oven dried and sieved to <0.063 mm (-230 mesh). The <0.063 mm fraction was analyzed by Chemex Labs Ltd., Vancouver, B.C., for 32 elements using ICP-AES following a nitric-aqua regia partial digestion on a 1.0 g aliquot. Till samples were also analyzed for Au, Pt and Pd using fire assay-AFS on a 30 g aliquot. Analytical methods and lower detection limits are listed in Table 1 and geochemical results are listed in Appendixes D and E. Analytical accuracy was

Table 1. Analytical methods and lower detection limits of all elements analyzed in kimberlite, till, humus and B and C horizon soil.

Element	Method	Lower Detection limit	Material
Ag ppm	ICP-AES	0.2 ppm	till, humus, B, C horizon
Al %	ICP-AES	0.01%	till, humus, B, C horizon
As ppm	ICP-AES	2 ppm	till, humus, B, C horizon
Au ppb	Fire assay/ICP-AFS	2 ppb	till, humus, B, C horizon
Ba ppm	ICP-AES	10 ppm	till, humus, B, C horizon
Be ppm	ICP-AES	0.5 ppm	till, humus, B, C horizon
Bi ppm	ICP-AES	2 ppm	till, humus, B, C horizon
Ca %	ICP-AES	0.01%	till, humus, B, C horizon
Cd ppm	ICP-AES	0.5 ppm	till, humus, B, C horizon
Co ppm	ICP-AES	1 ppm	till, humus, B, C horizon
Cr ppm	ICP-AES	1 ppm	till, humus, B, C horizon
Cu ppm	ICP-AES	1 ppm	till, humus, B, C horizon
Fe %	ICP-AES	0.01%	till, humus, B, C horizon
Ga ppm	ICP-AES	10 ppm	till, humus, B, C horizon
Hg ppm	ICP-AES	1 ppm	till, humus, B, C horizon
K%	ICP-AES	0.01%	till, humus, B, C horizon
La ppm	ICP-AES	10 ppm	till, humus, B, C horizon
Mg %	ICP-AES	0.01%	till, humus, B, C horizon
Mn ppm	ICP-AES	5 ppm	till, humus, B, C horizon
Mo ppm	ICP-AES	1 ppm	till, humus, B, C horizon
Na %	ICP-AES	0.01%	till, humus, B, C horizon
Ni ppm	ICP-AES	1 ppm	till, humus, B, C horizon
P ppm	ICP-AES	10 ppm	till, humus, B, C horizon
Pb ppm	ICP-AES	2 ppm	till, humus, B, C horizon
Pd ppb	Fire assay/ICP-AFS	2 ppb	till, humus, B, C horizon
Pt ppb	Fire assay/ICP-AFS	3 ppb	till, humus, B, C horizon
Sb ppm	ICP-AES	2 ppm	till, humus, B, C horizon
Sc ppm	ICP-AES	1 ppm	till, humus, B, C horizon
Sr ppm	ICP-AES	1 ppm	till, humus, B, C horizon
Ti %	ICP-AES	0.01%	till, humus, B, C horizon
Tl ppm	ICP-AES	10 ppm	till, humus, B, C horizon
U ppm	ICP-AES	10 ppm	till, humus, B, C horizon
V ppm	ICP-AES	1 ppm	till, humus, B, C horizon
W ppm	ICP-AES	10 ppm	till, humus, B, C horizon
Zn ppm	ICP-AES	2 ppm	till, humus, B, C horizon

monitored by comparing analytical results for GSC reference standards to recommended values (Appendixes D and E). Analytical precision was monitored by comparing duplicate analyses of selected samples (Appendixes D and E). Acceptable data are listed in Appendixes D and E. Data for Ag, Bi, Cd, Ga, Hg, La, Mo, Pt, Pd, Tl, U and W are not included in this report because the reported values are at or less than the lower detection limits listed in Table 1. Vegetation geochemical analyses were described by McClenaghan and Dunn (1995).

Gold Grain Counts

Gold grains were examined by Overburden Drilling Management Ltd. staff as part of the sample processing procedure (Fig. 5). Gold grains recovered during tabling and subsequent panning were counted and their size estimated and then returned to the sample in preparation for geochemical analysis. Gold grains were classified using the three morphologic categories of DiLabio (1990; 1991) that reflect increasing distance of glacial transport: pristine, modified and reshaped. Pristine grains retain primary shapes and surface textures and appear not to have been damaged in glacial transport. Modified grains retain some primary surface textures but all edges and protrusions have been damaged during transport. Reshaped grains have undergone enough transport that all primary surface textures have been destroyed and the original grain shape is no longer discernible. The progression from pristine to reshaped grains is interpreted to represent increasing distance of transport. Estimated gold assays for each sample were calculated by Overburden Drilling Management Ltd. based on the abundance and size of the gold grains recovered. Gold grain abundance, size, shape and calculated assays are reported in Appendix F.

Pebble Counts

The 5.6 mm to 6 cm (pebble) fraction of trench A and B till samples was screened from the >2.0 mm (-10 mesh) fraction (Fig. 5) and individual clasts were classified into nine categories that reflect the major rocks types in the region:

1) felsic to intermediate intrusive rocks, including the monzonitic Garrison Stock; 2) mafic intrusive rocks; 3) metavolcanic rocks, including local basaltic rocks; 4) ultramafic rocks; 5) metasedimentary rocks; 6) Paleozoic carbonate rocks; 7) kimberlite; 8) vein quartz; and 9) other or unknown rock types. Pebble lithology abundances are listed in Appendix G.

RESULTS

Kimberlite and Till Geochemistry

Geochemical results for the <0.063 mm fraction of till and kimberlite samples are listed in Appendix D.2. Kimberlite geochemistry is very similar to that reported by Barron and Barnett (1993) and the average kimberlite composition reported by Mitchell (1986). Significantly lower values reported for Ni, Ba and Sr are likely a function of the digestion and analytical method because Barron and Barnett (1993) reported much higher values for the Buffonta dike similar to those reported by Mitchell (1986). The Buffonta dike is enriched in Au compared to average kimberlite (Mitchell, 1986) and this is likely due to the large volume of mineralized xenoliths in the dike.

Till geochemical data for Au, Al, Ba, Ca, Cr, Ni, Sr and Zn were plotted as proportional dots on north-south profiles (Appendix H) along trenches A and B to show element distribution relative to the kimberlite dike. The highest values of Cr, Ca, Ba and Al in till are overlying and just south of the dike, close to the bedrock surface. Ni and Zn values are also highest over and south of the dike although the patterns are more subtle.

Au data were plotted using the 20 ppb regional threshold for surface till samples in the region defined by McClenaghan (1992). Only two till samples contain anomalous Au concentrations (Appendix H) and they are likely related to mineralized volcanic rocks that surround the dike.

Till Lithology Data

One kimberlite pebble was found at each of two sites: six meters south of the dike in trench A and one meter south of the dike in trench B (Appendixes G and

H). The absence of kimberlite pebbles in most samples is not unexpected since kimberlite is a soft rock and clasts are unlikely to survive long glacial transport. The kimberlite matrix is composed primarily of soft minerals such as phlogopite, calcite and serpentine (Barron and Barnett, 1993), thus kimberlite would be easily crushed to sand and silt sized material during glacial transport. The lack of kimberlite pebbles in the till samples also could be a result of wet sieving of the samples during laboratory processing (Fig.5) which disaggregates soft material.

Two lithologies dominate the >5.6 mm pebble fraction: felsic to intermediate intrusive and metavolcanic rocks (including basalt that surrounds the kimberlite) and their distribution patterns in trenches A and B are plotted in Appendix H. Till samples closest to the bedrock surface just south of the kimberlite dike have the lowest concentrations of the local volcanic bedrock, contain kimberlite clasts (Appendix H) and have the highest felsic intrusive concentrations. Felsic intrusive-rich debris from the Garrison Stock would have been diluted by the incorporation of metavolcanic clasts as the glacial ice travelled back onto volcanic terrane down-ice (southwest or southeast) from the Garrison Stock (Fig.2), hence the high volcanic content overlying volcanic bedrock. Where the glacier carrying felsic intrusive-rich debris passed over the dike, kimberlite debris was incorporated. Since kimberlite clasts would not survive glacial transport, the resultant till appears to be felsic-rich in the coarse (>5.6 mm) fraction. If this is true, then the finer till fractions, (<0.063 mm, silt+clay) should reflect the incorporation of kimberlite in the felsic-rich zone.

Kimberlite Indicator Minerals

Kimberlite indicator mineral abundances for the pit and trench kimberlite samples are summarized in Table 2. Geochemical analyses are listed in Appendix C. Two profile plots showing the distribution of samples containing indicator minerals and Cr diopside abundance are included in Appendix H.

The kimberlite dike contains few indicator minerals. The two dike samples contain 14 Cr diopsides, several of which are very Cr-rich (1.70 to 2.57 wt.% Cr₂O₃), three Cr pyropes (G9 garnets according to Dawson and Stephens, 1975),

Table 2. Kimberlite indicator mineral abundance in till and kimberlite samples from the Buffonta property

Sample	Material	Location	Cr pyrope	Cr diopside	Mg ilmenite	Diamond Inclusion chromite	Total Number of Indicator minerals
92MPB001	till	pit		1			1
92MPB002	till	pit		11			11
92MPB003	till	pit		10			10
92MPB004	till	pit		12			12
92MPB005	till	pit		13			13
92MPB006	kimberlite	pit	1	2	1		4
92MPB300	till	trench A		1			1
92MPB301	till	trench A		1		1	2
92MPB306	till	trench A		3			3
92MPB307	till	trench A		2			2
92MPB308	till	trench A		1			1
92MPB314	till	trench A		1			1
92MPB330	till	trench A		1			1
92MPB331	till	trench A		1			1
92MPB332	till	trench A		3			3
92MPB336	till	trench B		2			2
92MPB337	till	trench B		4			4
92MPB339	kimberlite	trench B	2	12		1	15
92MPB340	till	trench B		5			5
92MPB343	till	trench B		3			3
92MPB344	till	trench B			1		1
92MPB345	till	trench B		1			1
92MPB347	till	trench B			1		1
92MPB348	till	trench B		2			2
92MPB351	till	trench B		2			2
92MPB355	till	trench B		1			1

one Mg ilmenite and one diamond inclusion (DI) chromite. In comparison, one sample from the C14 kimberlite pipe contains thousands of kimberlite indicator minerals (Averill and McClenaghan, 1993). Indicator minerals are even more rare in the till around the dike. No Cr pyrope was found in the till; two till samples in trench A contain one Mg ilmenite and one till sample in trench A contains one diamond inclusion (DI) chromite. Barron and Barnett (1993) report similar low indicator counts for the Buffonta dike. They found one very chromium-rich diopside (3.64 wt.% Cr₂O₃).

Size estimates for indicator minerals are included in Appendix C.

Approximately 50% the Cr diopside grains are 0.25 to 0.5 mm in diameter and 50% are 0.5 to 1.0 mm. Only a few grains are 1.0 to 2.0 mm (Table 2). The three Cr pyrope grains recovered are 0.5 to 2.0 mm in size. Mg ilmenites are all 0.5 to 1.0 mm.

Gold Grains

The number, shape and size of gold grains recovered from kimberlite and till samples are listed in Appendix F. Sixteen small gold grains were recovered from the trench B kimberlite, 15 of which are <50 µm in size, and six of which are pristine. No gold grains were found in the kimberlite sample from the pit edge. The gold grains in the kimberlite are probably from the mineralized quartz vein and felsic dike xenoliths.

Profile plots of gold grain counts and gold grain counts normalized to 10 kg of <2 mm material are included in Appendix H. Data were plotted using the five grain threshold defined for surface till samples in the region by McClenaghan (1992). Gold grain counts were normalized to 10 kg because the weight of <2 mm material in each till sample varies between 5 and 12 kg. A 10 kg weight was used for normalizing because it is the most common sample size used for drift prospecting in the region.

Every till sample contained gold grains, most of which are small (<50 µm) and reshaped. Most samples are anomalous in comparison to the five-grain regional threshold. The highest grain counts occur at similar depths in trenches A

and B; 1) just south of the kimberlite, close to the bedrock surface and 2) along the surface. The gold grains may have been derived from the mineralized bedrock, the kimberlite dike or the adjacent quartz vein. Pit sample 92MPB005, collected north (up-ice) of the kimberlite dike, contains 55 gold grains, several of which are small (<50µm) and pristine. McClenaghan (1992) reported similar large numbers of pristine gold grains southwest of the Garrison Stock in surface till samples collected in a regional till sampling program. Hence, sample 92MPB005 is a good example of the signature from the mineralized margin of the Garrison Stock.

Soil Geochemistry

Humus, B and C horizon results are listed in Appendix E.2. The soil is developed on an apparently homogenous sandy till. One sample each of humus, B horizon, and C horizon was collected at 11 sites as shown on Figures 2 and 3. The samples were collected on lines crossing the kimberlite dike to determine if the kimberlite could be detected by analysis of soil samples or humus.

The humus does not reflect the presence of the underlying kimberlite, i.e., it is geochemically homogenous and metal-poor. It contains higher levels of Ba, Cu, Mn, Pb, Sr, and Zn than the underlying B and C horizons. Gold concentrations in humus are highest (74 ppb) overlying the Garrison Stock on line 6 and the kimberlite dike on Line 8. It is not known if past development on the Buffonta property has contaminated the humus with wind-blown dust. The B and C horizon samples also do not reflect the presence of the underlying kimberlite. They contain higher levels of Al, Cr, Fe, Mg, and V than the overlying humus, but they are similarly homogenous and metal-poor. These data indicate that B and C horizon soil samples collected at the property scale and analyzed using aqua regia/ICP-AES are ineffective in detecting the kimberlite dike or gold mineralization around the Garrison Stock.

Vegetation Geochemistry

In contrast to the soil samples, vegetation shows some response over kimberlite and the surrounding mineralized bedrock. Pin cherry twigs overlying the kimberlite dike have elevated concentrations of Sr (2900 ppm) and Au (15 ppb) (McClenaghan and Dunn, 1993). The highest concentrations of Be, Cd, Mo, Ni and Ti in balsam fir twigs overlie the kimberlite dike on Line 6. These likely reflect the underlying mineralized bedrock and abundant mineralized xenoliths in the kimberlite dike. Au concentrations in both pin cherry and balsam fir twigs are highest overlying the Garrison Stock on line 6 and the kimberlite dike on lines 6 and 8. This pattern is similar to anomalous gold levels in humus. Geochemical responses in vegetation overlying kimberlitic rocks are not unexpected. Elevated concentrations of these elements in balsam fir and other plant species overlying kimberlites elsewhere have been reported by McClenaghan and Dunn (1995) and Dunn (1993).

CONCLUSIONS AND IMPLICATIONS FOR EXPLORATION

- 1) The Buffonta dike is a very small kimberlitic source. It contains a few grains of Cr pyrope, Mg Ilmenite and diamond inclusion Cr spinel and more numerous Cr diopside. Most of these indicator minerals are 0.5 to 1.0 mm in size.
- 2) The kimberlite dike contains anomalous concentrations of gold.
- 3) Kimberlitic material (pebbles and indicator minerals) was dispersed a minimum of 6 m down-ice (south) from the dike. The maximum distance down-ice that material was not determined.
- 4) Till geochemical data showed some reflection of the kimberlite and gold mineralization.
- 5) Humus, B and C horizon soil geochemical data do not reflect the underlying kimberlite. Humus gold data does reflect underlying gold mineralization.

6) Balsam fir and pin cherry twigs showed correlation to the gold mineralization and kimberlite.

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