REPORT ON THE MARK PROPERTY

PANGMAN PEAK 82N/15W

GOLDEN MINING DIVISION

LAT 51 DEGREES 47 MINUTES NORTH

LONG 116 DEGREES 58 MINUTES WEST

FOR

DIA MET MINERALS LTD.

KELOWNA, B.C.

BY

C.E. FIPKE

C.F. MINERAL RESEARCH LTD.

KELOWNA, B.C.

NOVEMBER 1990

CONTENTS

ASSESSMENT REPORT

MARK CLAIMS GROUP
GOLDEN M.D.

by C.E Fipke

1. INTRODUCTION:

The Mark Group consists of two contiguous claims totalling 18 units. The claims are presently 100% owned by Dia Met Minerals Ltd. of Kelowna, B.C. Norms Manufacturing & Geoservices Ltd. was contracted as operator to complete three years of assessment work with respect to the claims.

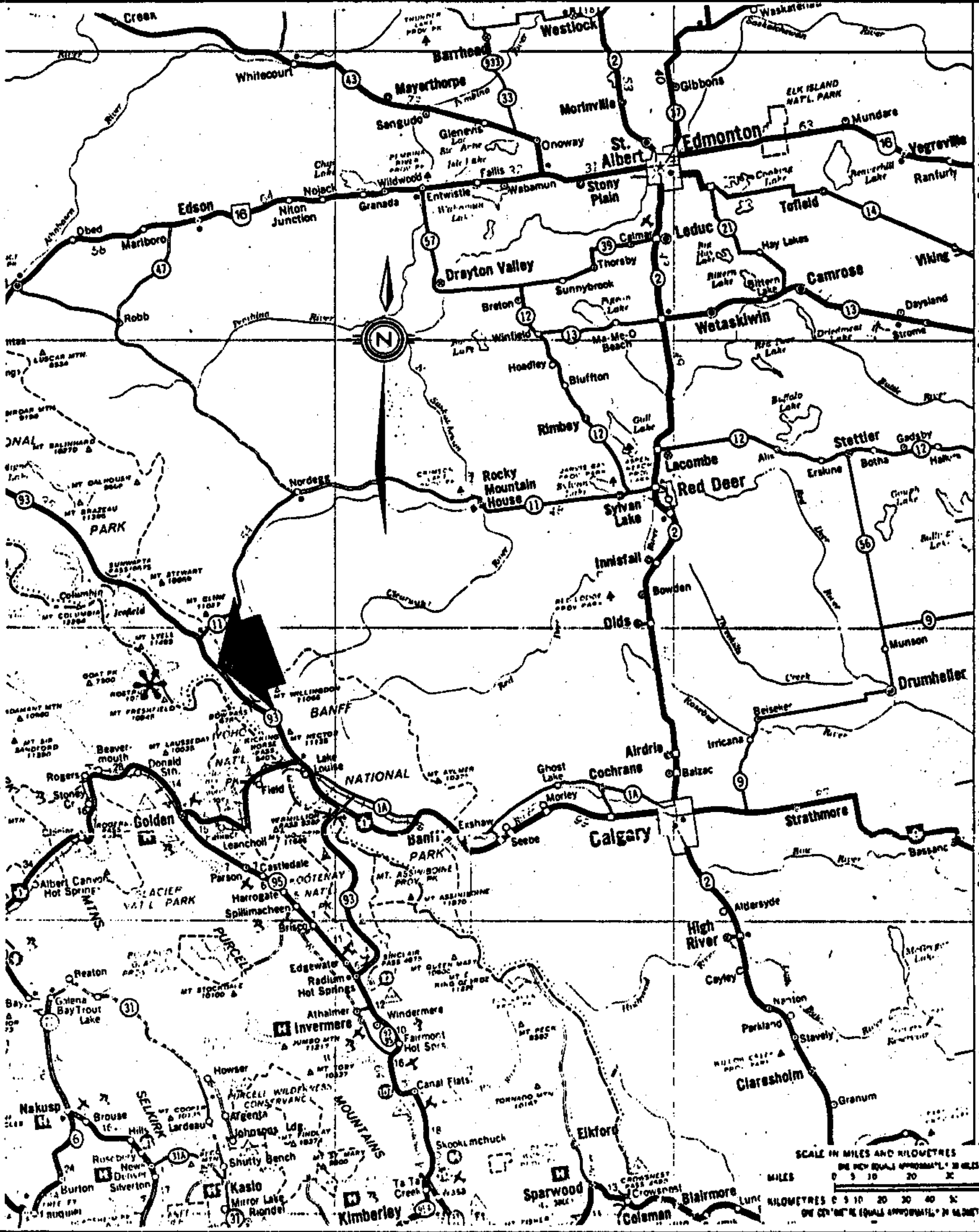
Previous work by Falconbridge Metallurgical Lab, prior to 1983, resulted in the detection of a single micro diamond, 13 chromite and a single picroilmenite of kimberlitic composition.

The present report objective of Dia Met Minerals Ltd. was to substantiate whether or not the minerals recovered by Falconbridge were likely to have originated from one of the Mark diatremes or from laboratory contamination. In addition, thin section studies were completed by kimberlite/lamproite expert petrographer Malcholm McCallum, professor of Geology at Colorado State University, to determine the nature of diatreme rock collected during his 1987 geologic mapping of six of the eight diatremes present on the claims.

2. LOCATION:

The Mark claim diatreme cluster (Figures 1 & 2) is situated astride the British Columbia-Alberta border approximately 41 km north-northwest of Golden, B.C. at longitude 116 degrees 57' 50"W and latitude 51 degrees 46' 48"N, NTS 82N/14E. Relief in the area is steep and maximum elevation is approximately 2896 meters. Eight well-defined breccia (?) bodies are present but only five of these have been authenticated as consisting of diatreme material (Fig. 3). Time constaints have prohibited on-site evaluation of the Mark 3 and Mark 1X bodies, which were established as possible diatremes on the basis of binocular scans and helicoper overflights.

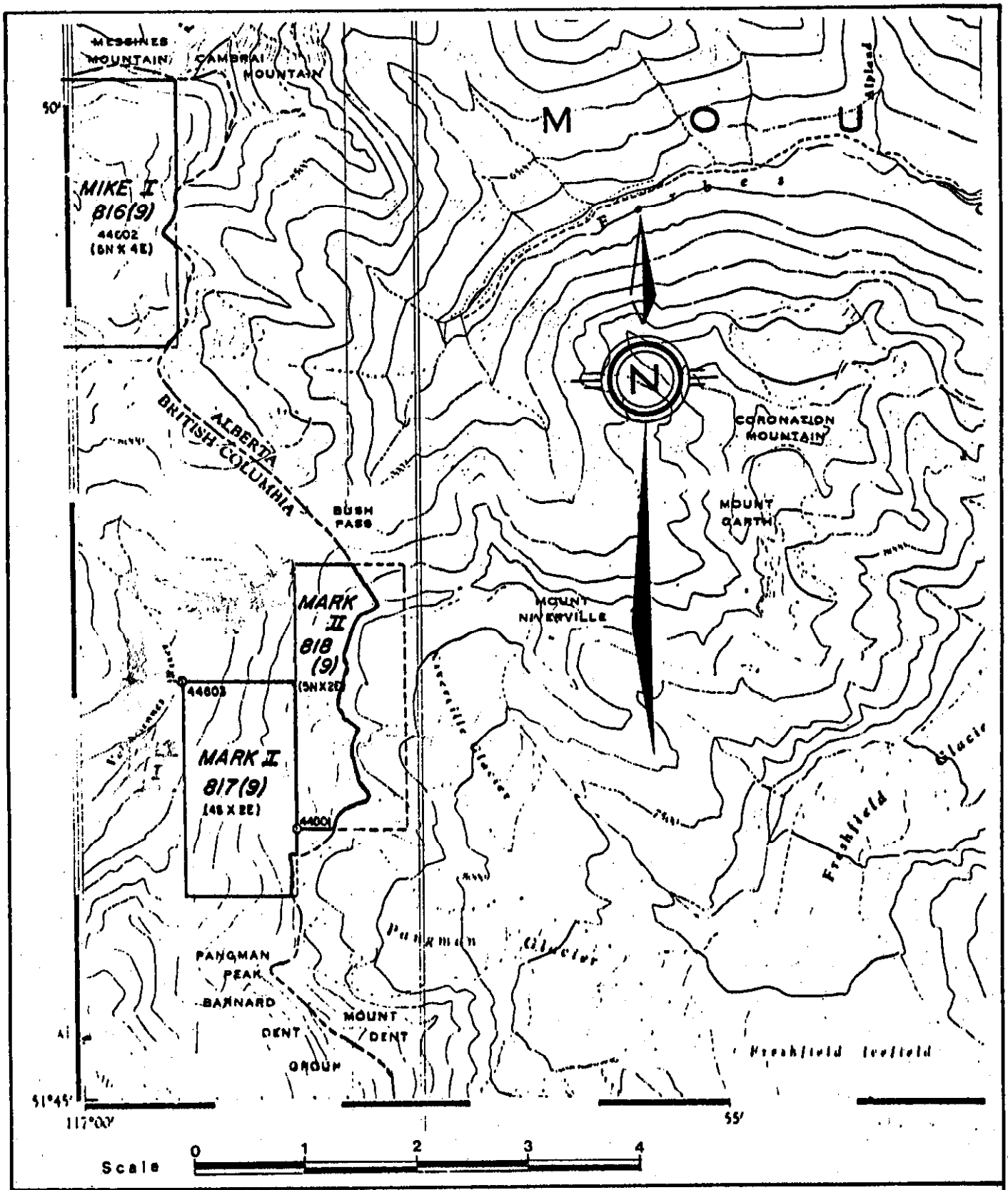
The claims are accessible by helicopter from Golden. There is a logging road within 10 kilometres, west of the property.



DIA MET MINERALS LTD
INDEX MAP
MARK PROPERTY

82N/15W	51° 47'N 116° 58'W
GOWER, THOMPSON & ASSOCIATES Drawn J. F. B.	K.E. NORTHCOTE AND ASSOCIATES LTD April 30 1983

Figure 1



DIA MET MINERALS LTD
CLAIM MAP
MARK PROPERTY

82 N/15W	51° 47'N 116° 58'W
GOWER, THOMPSON & ASSOCIATES Drawn J. F. B.	K. E. NORTHCOTE AND ASSOCIATES LTD April 30 1983

Revised By G.D.T. June 10, 1983

Figure 2

3. LOCAL GEOLOGY:

No known detailed geologic studies have been conducted in this area, and the limited areal extent and time constraints on Dr. McCallum's 1987 mapping precluded the collection of much detailed stratigraphic and/or structural data. However, a generalized compilation of the geology of the southeast Cordillera by R.B. Campbell (1972) indicates that the northwest trending, southwest dipping Mons Fault probably extends beneath the Niverville Glacier several hundred meters(?) east of the Mark diatremes. The upper plate of the Mons Fault is reportedly comprised of Cambro-Ordovician sediments, and a northwest trending (approximately 60 degrees) anticline is present about a kilometer southwest of the diatreme cluster (Campbell, 1972). Sedimentary units in the map area (Fig. 3) consist of an upper dolomite sequence, a middle limestone and mudstone sequence, and a lower massive limestone unit. These may correlate with the lower part of the Middle to Lower Ordovician Skokie Formation, the Lower Ordovician Outram Formation, and the uppermost part of the Lower Ordovican Sunny Peak Formation respectively as described by Norford (1969). All of these units are characterized by a well defined, moderately to steeply dipping (60 - 80 degrees SW), northwest trending axial plane(?) cleavage (Figs. MR-4 and MR-5) that is essentially parallel to the axis of the nearby anticline depicted on Campbell's (1972) geologic map.

4. GEOLOGY OF THE DIATREMES:

The Mark 1, 3, 4, 5, and 6 diatremes (Fig. 2) all straddle the sharp, rugged northerly trending divide that separates British Columbia and Alberta (Fig. 3). The western portions of these bodies are completely exposed in cliff to near cliff faces, whereas eastern extensions, except for the Mark 1 pipe, are entirely covered by the Niverville Glacier in Alberta. Although the Mark 1 diatreme, the largest pipe in the cluster, also extends beneath the Niverville Glacier, a significant portion is will exposed east of the divide for approximately 250 meters in an east trending arete. Fabric within the Mark 1X breccia body (exposed surface area about 40 x 150 meters) to the southeast could be an extension of the main Mark 1 body, and if so, the surface area of the Mark 1 diatreme could have maximum dimensions of as much as 250 x 1200 meters. Even with a more conservative estimate of its extent beneath the glacier, the Mark 1, with dimensions of at least 250 x 550 meters, is one of the largest known diatremes in the Canadian Rockies. The Mark 3(?), 4, 5, and 6 diatremes are all roughly elliptical with average dimensions of approximately 65

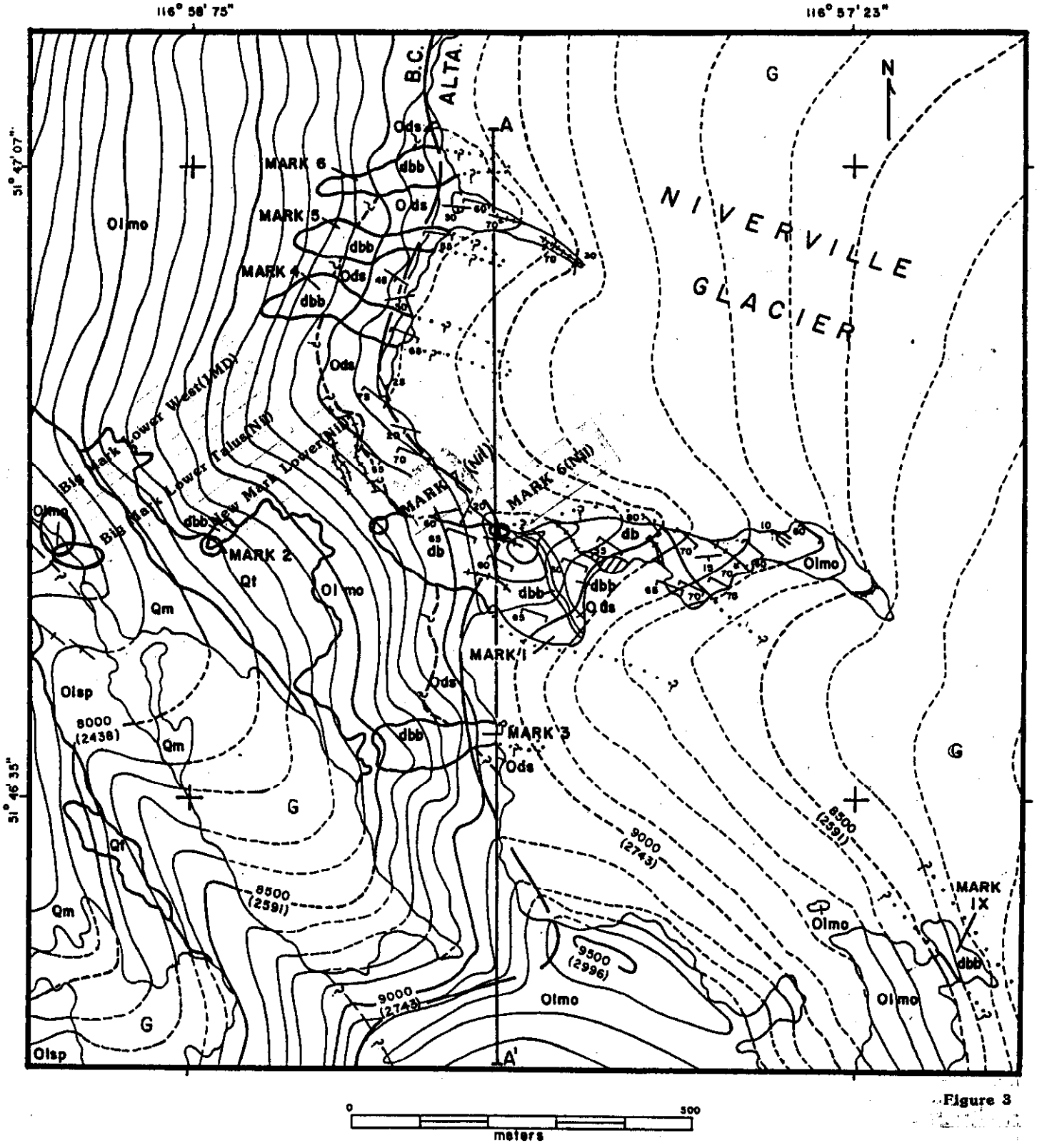


Figure 3

Contour Interval 100 feet (30.48 meters)

MARK AREA EXPLANATION

MESOZOIC - CENOZOIC

— QUATERNARY —

G — **GLACIERS and PERENNIAL SNOWBANKS**

Qt — **TALUS**

Qm — **MORAINE**

— CRETACEOUS(?) - TERTIARY —

LAMPROPHYRIC(?) DIKES: pale to dark green to greenish black, aphanitic to porphyritic or microporphyritic and locally trachytic, average 0.3-5 m thick; most phlogopite(?) bearing (both fine groundmass and coarser macrocrystal phases), small (< 3mm) rounded grains of analcite(?) or olivine pseudomorphed by carbonate locally common; weakly to intensely sheared especially along contacts or dikes within diatreme breccia where intrusive dike breccia phases are not uncommon; locally cut by shallow dipping (< 40° NE) 1-10 cm thick quartz + calcite ± ankerite (?) veins that generally are confined to dike particularly where in host sedimentary units.

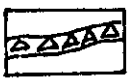
dbb
db

DIATREME BRECCIA: "tuffisitic(?) breccia" (crystal-lithic and lithic ash-lapilli tuff varieties) ranging from coarse (clasts average 10-3 cm but may exceed 1 m) to fine (clasts < 0.5 cm), contains local well bedded, sandy to pebbly horizons or lenses (generally < 2m thick); clasts moderately to well aligned and consist predominantly of nearby supracrustal sediments (dolomite, limestone, mudstone, siltstone, quartzite and argillite), rounded clasts of basalt/andesite and/or phlogopite(?) lamprophyre (lamproite?) common and may comprise bulk of clast material locally, deeper crustal granitic fragments less common and typically are intensely altered (carbonitized and/or oxidized); "sandy" crystal clast rich variety typically contains abundant well rounded quartz grains (most <0.5 mm) with variable amounts of phlogopite and pseudomorphed olivine + pyroxene ± amphibole ± K-feldspar; quartz poor variety contains more ferromagnesian crystal clasts and commonly is enriched in lamprophyric(?) pelletal lapilli and ash grains; groundmass typically is mostly finely crystalline to microcrystalline dolomite/calcite + chlorite + sericite ± orthoclase(?) ± quartz (fibrous) + leucoxene + leucoxenized perovskite and/or sphene + opaque oxides + pyrite; prominent cleavage parallel or subparallel to axial plane(?) cleavage in host sediments; locally sheared along cleavage surfaces.

MESO - CENO

CRET - TERT

dbb; pale brown to dark brown to locally red or maroon weathering gray to olive gray breccia, common in central part of Mark 1 pipe and in outlying pipes.
db; dark gray to gray green weathering pale gray to olive gray breccia characteristic of much of the Mark 1 pipe.



TECTONIC BRECCIA: brown weathering, gray, clast supported, dolomite (Od) breccia; matrix less than 5 percent and consists mainly of rock flour set in angular wallrock clasts; minor lamprophyric(?) tuffisitic breccia matrix material may be present locally; occurs in a tabular to irregular zone at central north edge of Mark 1 pipe; little evidence of significant fragment transport or rounding.

PALEOZOIC

ORDIVICIAN

Ods

ORDOVICIAN(?) DOLOMITE: pale to dark brown and buff weathering, pale to medium gray, thin to medium bedded (1-2cm), fine-grained dolomite with abundant buff orange to orange brown, silty to clayey layers (1-20 mm) and locally interbedded pale gray weathering, gray, thin (2-20 mm) to thick (1-2 m) bedded gray limestone; silty-clayey layers commonly accentuate prominent crenulations and minor folds (wavelengths a few mm to several tens of cm) (may correlate with the lower part of the Middle to Lower Ordovician Skokie Formation - Norford, 1969).

Olmo

ORDOVICIAN(?) LIMESTONE-MUDSTONE: gray to buff or brown weathering, medium to dark gray, thin to medium bedded (1cm -0.5m) commonly argillaceous limestone with abundant buff to orange brown, silty to clayey, platy to irregular layers (1 mm - 1 cm thick); interbedded orange brown weathering, gray brown calcareous mudstone and siltstone locally abundant (may correlate with the Lower Ordovician Outram Formation - Norford, 1969).

Olsp

ORDOVICIAN(?) LIMESTONE: gray weathering, dark gray, thick bedded (0.3-2.0 m), fine-grained limestone with thin to medium interbeds (1-30 cm) of orange brown weathering, clayey to silty gray limestone (may correlate with the upper massive member of the lower Ordovician Survey Peak Formation).

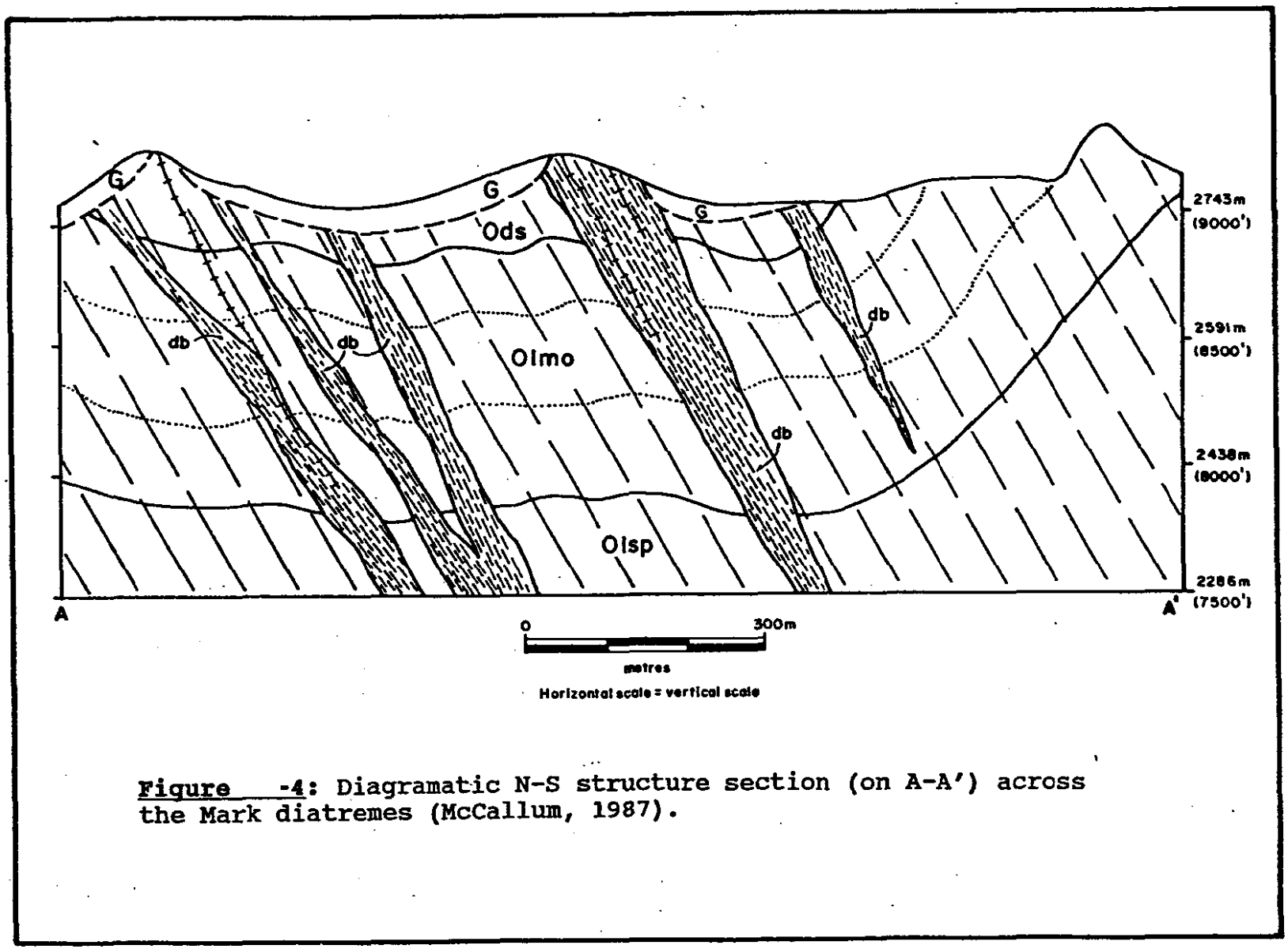


Figure -4: Diagramatic N-S structure section (on A-A') across the Mark diatremes (McCallum, 1987).

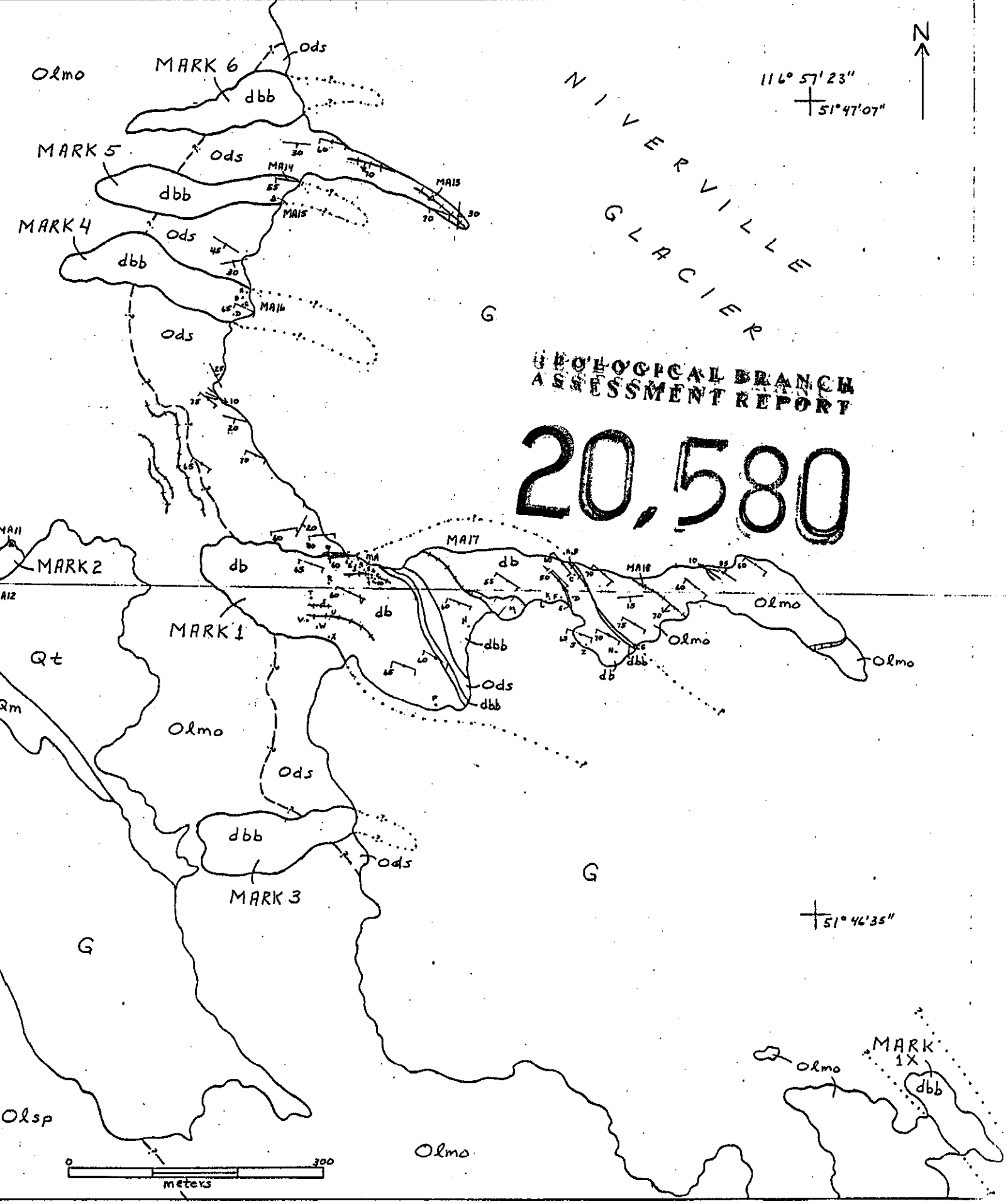


Figure 5

x 220 meters. The Mark 2 body, located about 210 meters west of the Mark 1, is approximately 30 x 50 meters, and may be a small outlier of the Mark 1 structure.

5. METHOLOGY OF PRESENT STUDIES

Three (-0.85 + 0.075)mm heavy non-magnetic concentrates previously concentrated from (+ or -) 35 kg rock samples collected at sites Mark 7, New Mark Lower and Big Mark Lower talus (Fig. 3), were fused using a 12 stage proprietory method of the C.F. Mineral Research Ltd. laboratory. The (+ or - 0.1gm) resultant fused products were centrifuged onto scanning electron microscope mounts and examined by geologist C. Fipke for the presence of (-0.85 + 0.075)mm microdiamonds. Several (unlikely) possibilities were tested for "C" and other elements utilizing the C.F.M. windowless scanning electron microscope.

In addition, three polished sections of about 1000 grains of mostly oxide minerals (chromites and ilmenites) were made from chromites extracted from heavy mineral concentrates of rock collected from sites Mark 6, Mark 7, New Mark Lower, and Big Mark Lower talus (Fig. 3). These were S.E.M. scanned for Ca-Al-Ti-Cr-Fe-Mg and each of the foregoing elements printed out on a color printer. On the basis of the color combinations, 281 grains were selected and S.E.M. analysed for SiO_2, Cr_2O_3, FeO, MnO, MgO, CaO, Na_2O, K_2O, NiO, Nb_2O_5 and Cl.

The analytical results were firstly computer classified into mineralogic species. The resultant chromites were computer plotted on Cr_2O_3-MgO binary diagrams for comparision with the compositional field of chromites included in diamond from worldwide sources.

Twenty two thin sections were made by Ray Lund from rocks collected in 1987 by Dr. M. McCallum at sites located on Figure 5. Nine of the thin sections were petrographically descripted by Dr. McCallum from least altered rocks from the largest Mark (1) diatreme; and two from the Mark 4 and Mark 5 pipes (Fig. 5.)

6. RESULTS:

No micro or micordiamonds were recovered from the three (+ or -) 35 kg rock samples which were collected from diatreme rock sample sites Mark 7 and New Mark Lower and talus rock site Big Mark Lower talus. The minerals S.E.M. tested were corrundum. Several blue sapphires were present in the fused concentrates of the three

MARK SAMPLE — CHROMITES

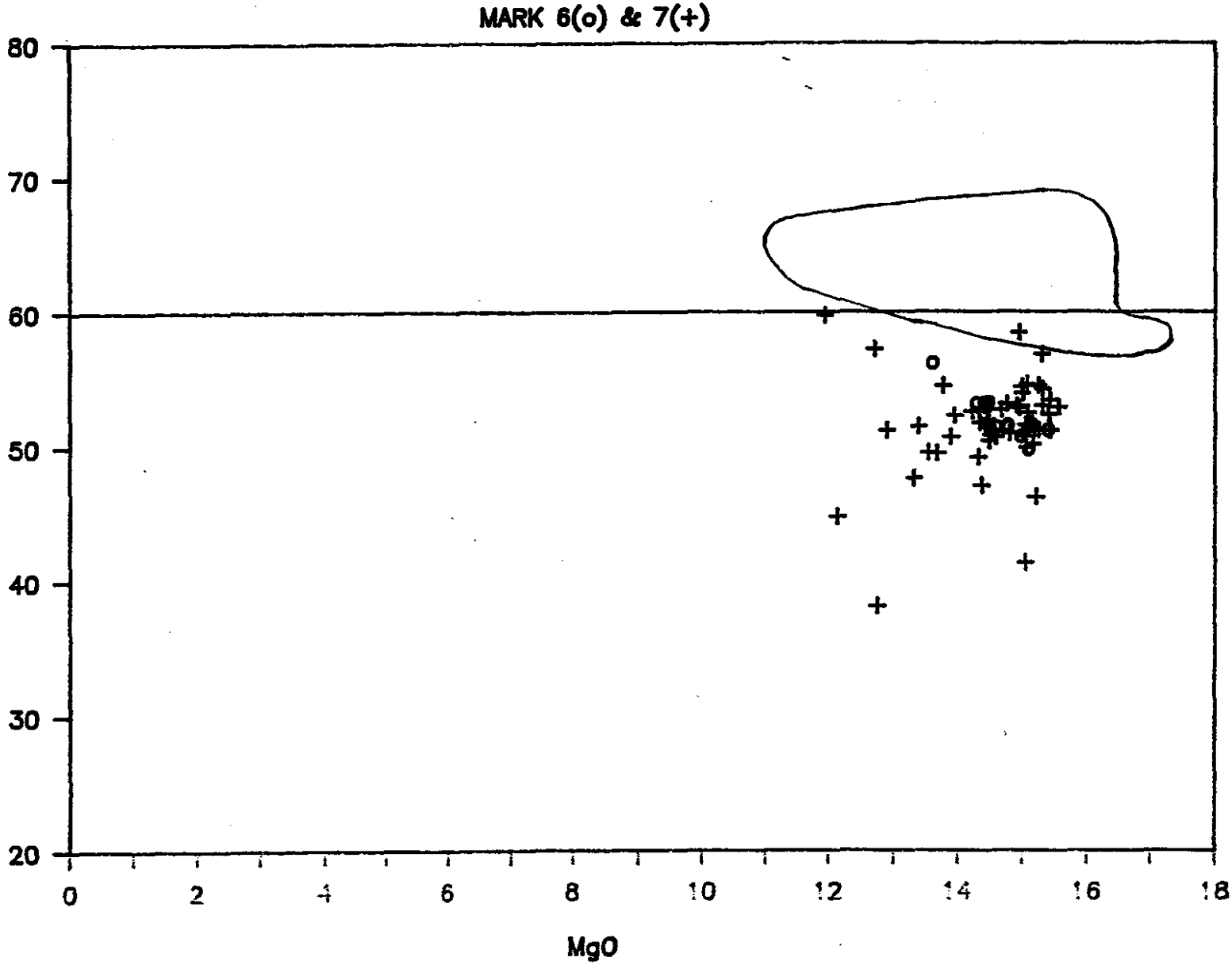


Fig. 6

MARK SAMPLE – CHROMITES

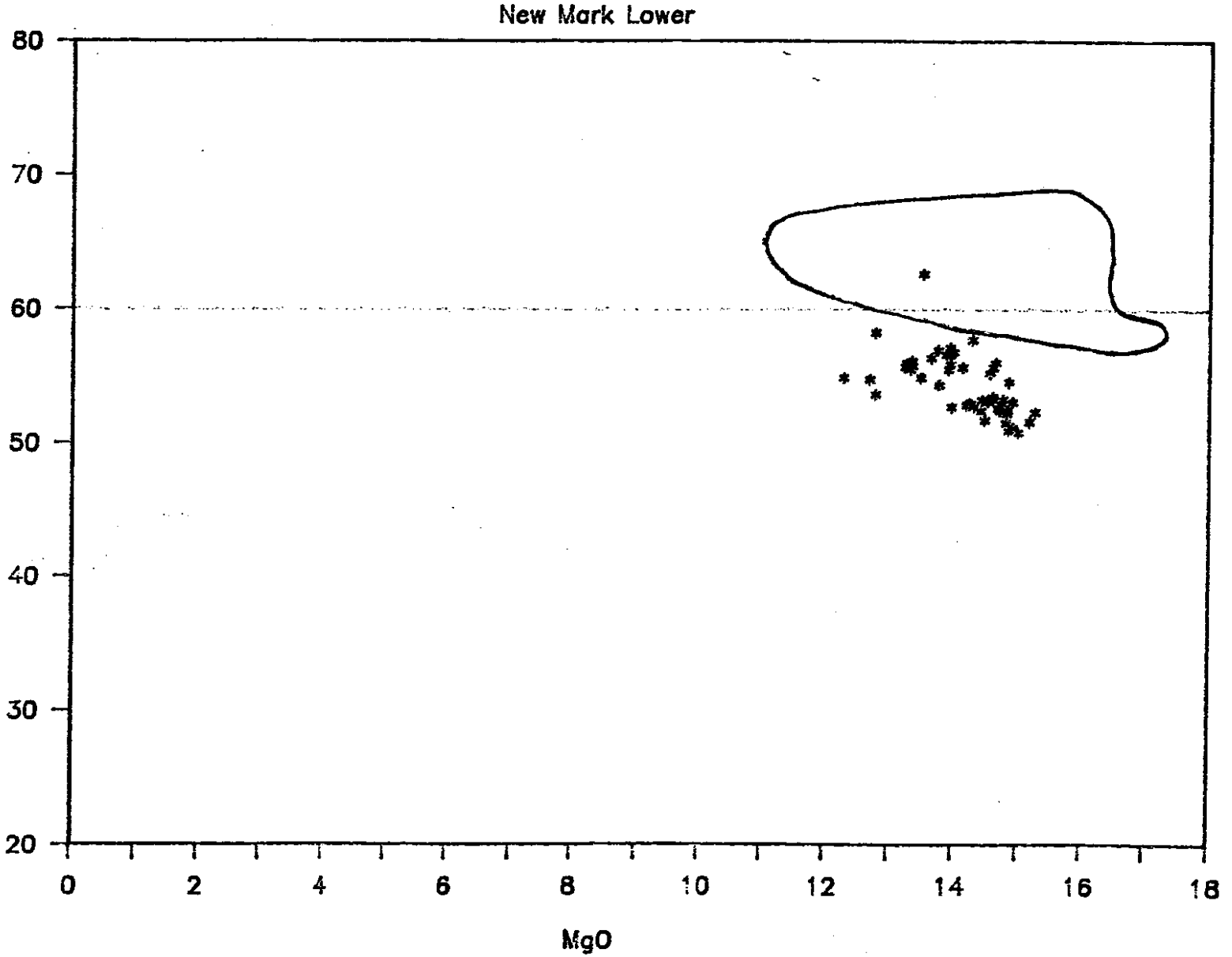


Fig. 7

MARK SAMPLE – CHROMITES

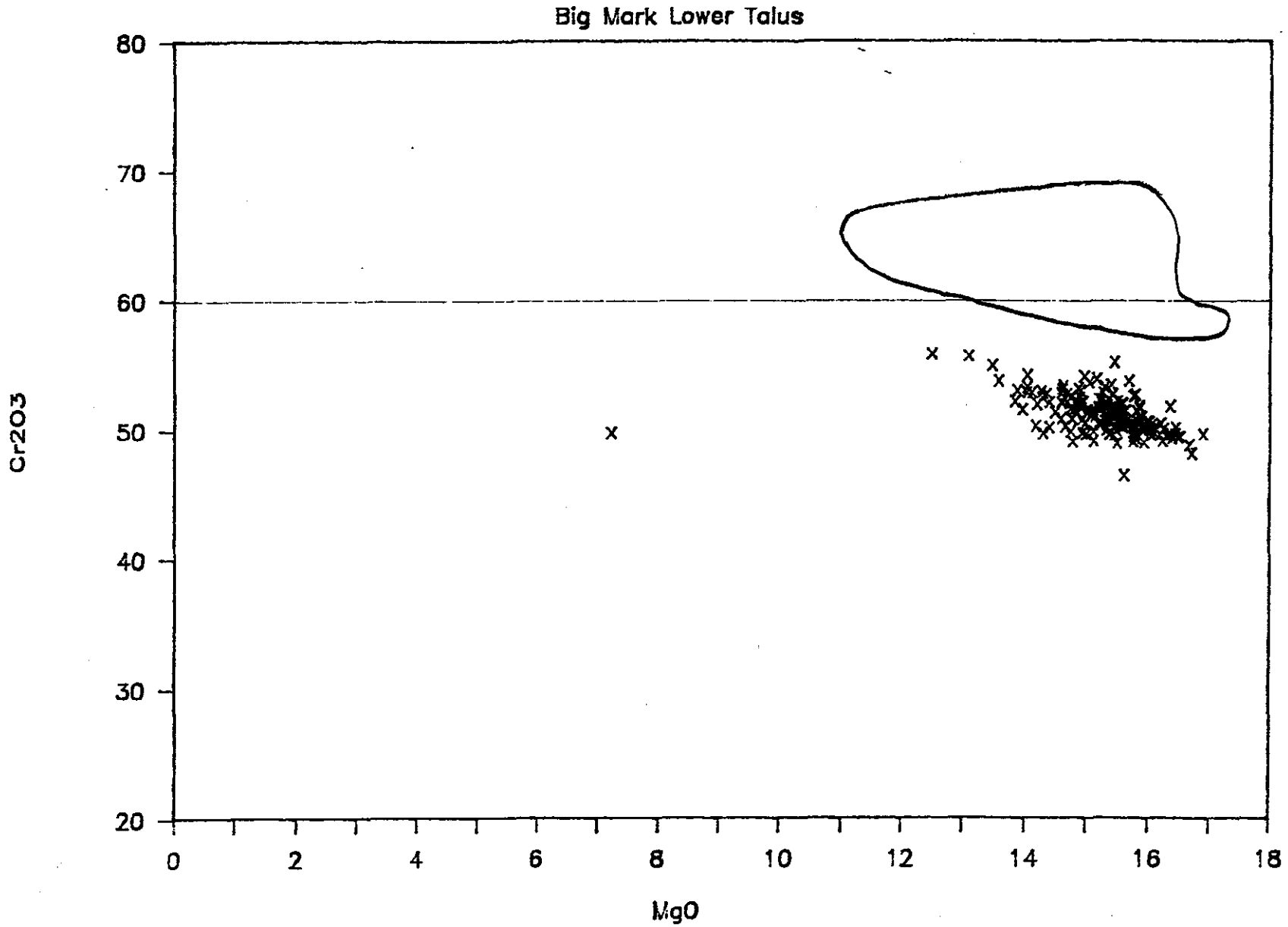


Fig 8

samples. The microdiamond sample sites and results are plotted on Figure 3 along with the previous Falconbridge Metallurgical result sample reported to contain a single commercial microdiamond.

The S.E.M. analytical results are given as Appendix A. These indicate 275 of the grains analysed were chromites. Picroilmenite, rutile and ankerite identified in concentrates from the Big Mark Lower talus, and picroilmenite and ilmenite from New Mark Lower diatreme rock sample concentrates.

Figures 6 to 8 illustrate that two of the chromites from diatreme rock, from sites Mark 7 and New Mark Lower, plot in the field of chromites included in diamond. The Mark 7 rock sample is from the largest Mark 1 pipe and the New Mark Lower rock sample is from the Mark 2 pipe thought to be an outlier of Mark 1.

The petrographic descriptions of Malcholm McCallum are given as Appendix B.

Summary of the detailed petrographic descriptions and age relations completed by Dr. McCallum is as follows:

PETROGRAPHY:

A summary of the main petrographic features of the various phases which constitute the Mark diatremes is presented below. Detailed petrographic descriptions for individual samples are provided in Appendix 6.

All of the evaluated Mark diatremes are comprised predominantly of diatreme facies, "tuffisitic (intrusive) breccia". Most of the breccia phases are matrix supported, but coarse, clast supported breccia occurs locally in thin (1-2m) layers or lenses. Clasts generally range from approximately 5mm to 10cm, but coarser breccia phases have abundant 10-30cm clasts, and blocks in excess of 1m are not uncommon. The most abundant phase is a "sandy", rounded quartz grain-rich, crystal-lithic ash-lapilli tuff variety (Plate MR-1), but quartz-poor lithic ash-lapilli tuff types (e.g. Plate MR-2) also are common. Most all phases are characterized by variable amounts of block sized clasts. Fragments range from subangular to well rounded and consist primarily of supracrustal wallrock sediments (dolomite, limestone, mudstone, siltstone, quartzite and argillite). However, rounded clasts of fine- to coarse- grained phlogopite(?) bearing to phlogopite(?) rich lamprophyre (lamproite?) are locally common and in some, minor phases may comprise the bulk of the clast material (e.g., sample site MA17H at Mark 1, Fig. [illegible]-5, Plate MR-3). Lapilli and ash sized grains (many pelletal) predominate, essentially all are porphyritic or microporphyritic,

and varieties range from vitrophyric and aphanitic to locally medium grained. Most contain phenocrysts (or microphenocrysts) of olivine and pyroxene replaced by dolomite ± calcite ± quartz and dolomite ± calcite ± chlorite, respectively. Amphibole replaced by leucoxenized chlorite ± sericite ± dolomite is abundant in some clasts, and a few contain phenocrysts of sanidine, both fresh and partially sericitized and/or replaced by quartz. Phlogopite is present in widely varying amounts and ranges from fresh to completely replaced by leucoxenized chlorite ± sericite. Lamprophyre clast groundmasses typically are intensely leucoxenized and consist of variable amounts of microcrystalline dolomite + sericite + chlorite + orthoclase(?) + leucoxenized perovskite and opaque mineral grains. Some chlorite, both groundmass and pseudomorphed phenocrystal, appears to be enriched in Cr, and some of the coarsest sericite appears to be fuchsitic.

Well rounded to subangular fragments of basalt and/or andesite also are abundant locally (e.g. sample site MA17K, Mark 1) (Fig .-5, Plate MR-3). These are characterized by abundant small laths of plagioclase (partially to completely replaced by sericite ± calcite ± albite) set in a groundmass of pyroxene (replaced by chlorite + dolomite + goethite/ limonite) and oxidized magnetite and ilmenite(?). Phenocrysts of olivine, pyroxene and plagioclase in porphyritic varieties are completely altered and pseudomorphs are rimmed by concentrations of goethite/ limonite.

A few deeper crustal fragments of granitic rocks were observed, but these typically are intensely altered (carbonatized? and/or hematitized). Groundmass material is similar to that reported for the Jack diatreme breccias, except degree of alteration does not appear to be quite as severe (less sericite?).

The dominant "sandy" phase is characterized by well rounded to oblong quartz grains (most <0.5 mm) that may comprise more than 15% volumetrically of the total rock. Smaller quartz grains (<0.2 mm) typically are more angular and rarely comprise more than 1-2% of any given sample. Intensely sericitized clasts of K-feldspar are common locally as are angular dolomite clasts that may be partially replaced by microcrystalline dolomite along their borders. Crystal clasts of pseudomorphed olivine + pyroxene ± amphibole and generally unaltered phlogopite may be present in small concentrations, but typically are considerably more abundant in quartz-poor lamprophyric(?) pelletal lapilli-rich phases. Olivine and pyroxene clasts are replaced by dolomite ± calcite, and pyroxene pseudomorphs generally have interiors dusted by leucoxene and may contain chlorite. Amphibole and phlogopite (where altered) are replaced by leucoxenized chlorite and local sericite. Pseudomorphs generally are rimmed by aggregates of finely crystalline leucoxene and some have thin rims of leucoxenized anatase(?). Rounded grains of variably altered opaque oxides (chromite, ilmenite?, titanates?) occur sporadically, and two well rounded grains (<0.25 mm) of tourmaline (dravite?) were noted. These mineral clasts and rock

flour fragments (fine ash) are set in a matrix of mostly finely crystalline to microcrystalline dolomite/calcite with variable amounts of chlorite, sericite, orthoclase(?) and quartz (typically fibrous). Leucoxene is pervasive, and tiny equant leucoxenized grains (<0.02 mm) of perovskite and/or sphene are abundant. Small isolated leucoxenized opaque mineral grains probably are ilmenite and/or titanates, and spinels are present locally. Small euhedral grains (most <0.25 mm) of pyrite commonly are present.

Many exposures exhibit moderately intense locally pervasive alteration to hematite, and shallow (several mm to cm) surface oxidation to goethite and/or "limonite" is common (dbb). Non-oxidized exposures (db) typically weather dark gray to gray green, but bulk compositions are essentially identical to their oxidized counterparts (dbb).

The Mark 2, 4, and 5 diatremes consist predominantly of pale brown to orange brown weathering, pale gray to olive gray, coarse, "tuffisitic breccia" (dbb). Both somewhat "sandy" (>5% rounded quartz clasts) and "non-sandy" (<2% quartz clasts) varieties are present. Pseudomorphs of olivine + pyroxene $\pm$ amphibole and variably altered phlogopite comprise the majority of the crystal clast population in the non-sandy breccia.

A minor intensely oxidized red phase is present near the south contact of the Mark 4 pipe (sample site MA16D, Fig. MR-5), and probably reflects greater mobilization of very late oxidizing fluids along that interface. Phlogopite(?) clasts occur in variable concentrations in these pipes, but are relatively abundant in the Mark 2 breccia.

The Mark 1 pipe contains a variety of phases but most are not of sufficient extent or continuity to warrant subdivision. Only two principal phases were mapped; a dominant dark gray to gray green weathering pale gray to olive gray breccia (db) and a pale brown to dark brown weathering gray breccia (dbb). Minor intensely oxidized red to maroon phases occur locally. The breccias range from crudely bedded coarse varieties to well bedded fine to medium grained, locally pebbly varieties. The finer grained phases rarely exceed a few meters in thickness, and typically are intimately interbedded with the coarser phases. Locally pelletal phases (Plate MR-2) enriched in well rounded lamprophyric lapilli and ash grains reflect an earlier "autolithic" fragmentation process.

All phases of the Mike 1 diatreme, as well as the other pipes in the cluster, exhibit a prominent moderate to steeply dipping (50-70^{o} SW) northwest trending cleavage that is roughly conformable to that in the host sedimentary units (Figs. MR-4 & MR-6). This cleavage conforms with bedding features in the diatreme breccia facies, and appears to have controlled the directional fabric of locally sheared facies (e.g., sample sites MA3, MA8 and MA9, Mark 1, Fig. '-5). A large, southwest dipping tabular slab of gray

dolomite in the Mark 1 pipe also appears to be conformable with this prominent cleavage. Planar fabric observed at the thin section scale is imparted by the strong parallel alignment of elongate clasts and segregationary concentrations of finely comminuted debris and wispy shreds of sericite and chlorite (Plates MR-1 & MR-4). Fine grained opaque minerals and microcrystalline to cryptocrystalline leucoxene commonly are abundant in zones of maximum shearing and accentuate the planar fabric.

Mafic, phlogopite(?) and/or analcite(?) (or olivine pseudomorphed by carbonate) bearing (lamprophyric?) dikes are relatively abundant in the area, and most appear to roughly conform with cleavage. Several intrude breccia of the Mark 1 pipe where they commonly have been intensely sheared (e.g., sample sites MA5, MA6, and MA17S, Fig. -5) and locally contain intrusive breccia phases. Quartz + calcite $\pm$ ankerite (?) veins (1-10 cm wide) are locally common in the dikes. The veins dip at low angles (< 40^{o} NE) and are generally confined to the dikes. They probably represent gash features which were generated during post-tectonic relaxation processes. Relaxation slippage along axial plane cleavage in host rocks probably promoted partial solution of quartz and carbonates from local siliceous limestone and/or calcareous mudstones and siltstones. Some of the lamprophyric(?) dikes may be genetically related to the tuffisitic diatreme breccias as also may be the lamprophyric(?) (lamproitic?) clasts within the breccias. More detailed petrographic and chemical data are needed to ascertain such a relationship, but preliminary evaluation of the various phases do not suggest a kimberlitic affinity for either diatreme breccia or hypabyssal dike phases.

AGE

All of the Mark diatremes appear to be moderately to steeply southwest dipping, elliptical to tabular shaped bodies that conform geometrically with the axial plane cleavage of the host sedimentary units (Figs. MR-4 & MR-6). This pronounced conformity is similar to that observed at the Jack and Mike diatremes and strongly implies axial plane cleavage control on diatreme emplacement. Presence of a comparable cleavage fabric in the diatreme breccias probably reflects slippage related to very late syntectonic deformation or post tectonic relaxation processes. There is no evidence of folding in the diatremes which likely precludes pre- or early syntectonic emplacement and infers at least a post Columbian orogeny (<98 Ma) age. Emplacement probably occurred during the latest stages of or shortly after the Laramide orogeny (< 60 Ma), but this can not be definitively ascertained without radiometric age dates.

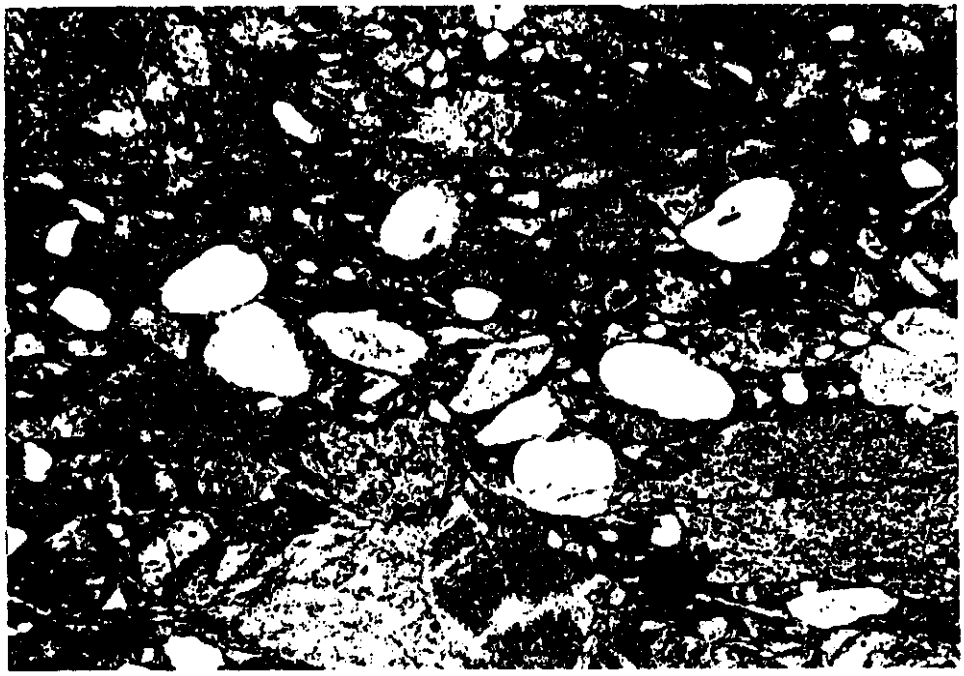


Plate MR-1: Photomicrograph of "sandy" crystal-lithic ash-lapilli tuff breccia (tuffisitic breccia - db) showing abundant rounded and angular quartz grains, subrounded to angular sedimentary rock clasts (e.g. lower right) and pelletal lamprophyre (lamproite?) lapilli (e.g. upper left, lower left). Note weak irregular E-W foliation imparted by elongate clasts and alignment of wispy chlorite and sericite. Breccia groundmass dominated by carbonate. Plane polarized light, long dimension field of view 4.4 mm. Sample: MA 17P.

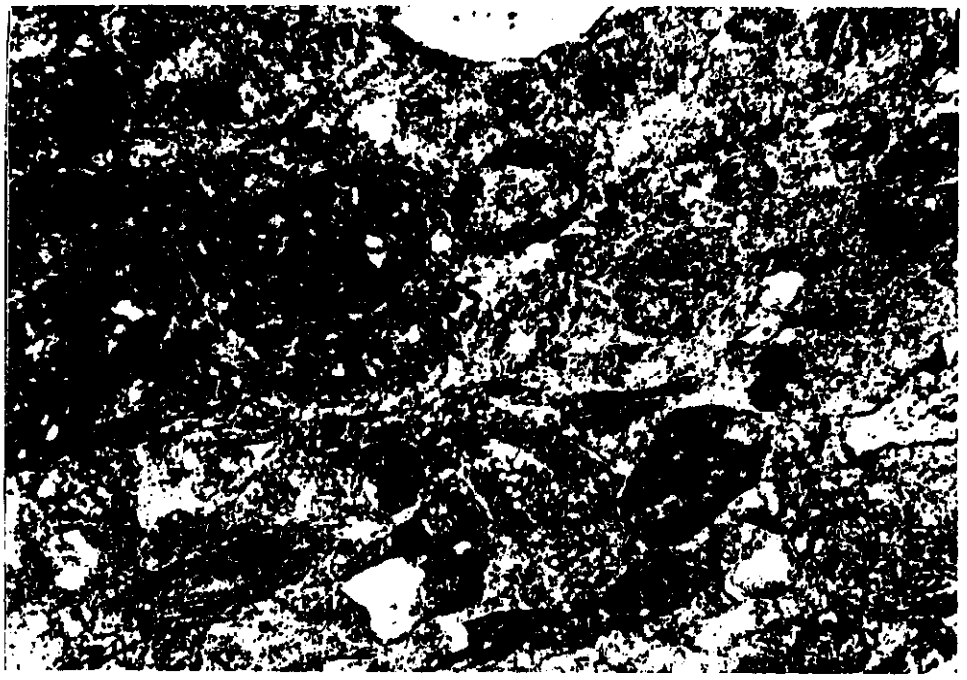


Plate MR-2: Photomicrograph of lithic ash-lapilli tuff breccia (tuffisitic breccia - db) with abundant pelletal lapilli of lamprophyre(?) (phlogopite-olivine lamproite?). Quartz and sedimentary rock clasts relatively rare. Breccia groundmass dominated by dolomite, calcite and chlorite with minor sericite and patchy areas of finely crystalline orthoclase (?). Plane polarised light, long dimension field of view 11 mm. Sample: MA 17K.

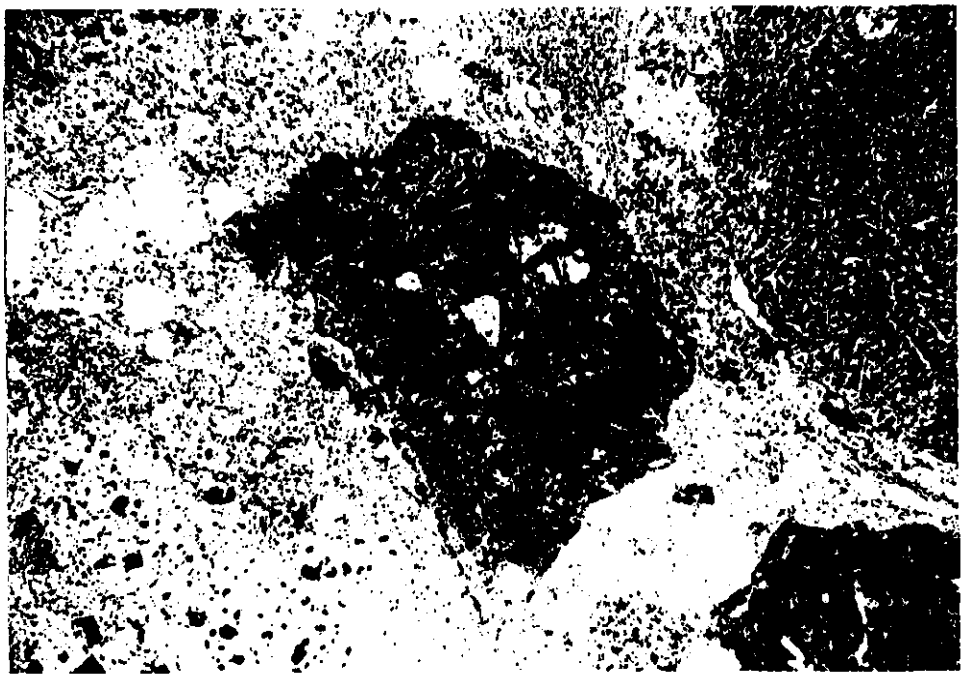


Plate MR-3: Photomicrograph of lithic ash-lapilli tuff breccia (tuffisitic breccia - db) with two fragments of plagioclase lath-rich basalt (central clast contains olivine phenocrysts replaced by calcite). Clast in lower right corner is a phlogopite-olivine-pyroxene lamprophyre (lamproite?). Clear rounded grains in breccia groundmass are quartz; groundmass consists of microcrystalline to cryptocrystalline dolomite + sericite + chlorite + orthoclase(?) + quartz + leucoxenized perovskite(?), anatase(?) and opaque minerals. Plane polarised light, long dimension field of view 4.4mm. Sample: MA 17H.

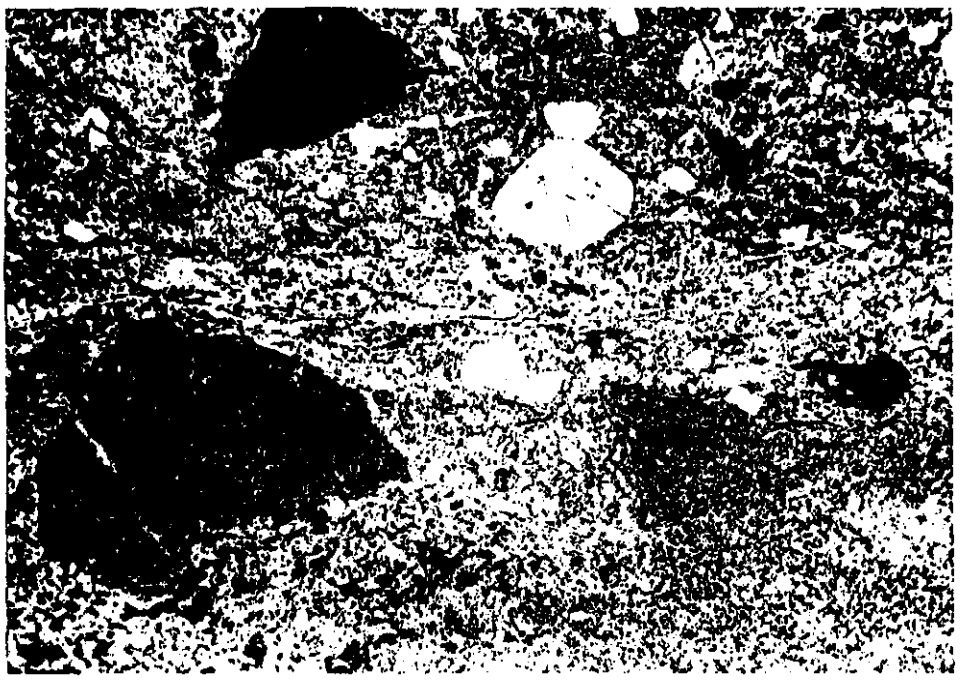


Plate MR-4: Photomicrograph of lithic ash-lapilli tuff breccia (tuffisitic breccia - db) showing E-W zone of shearing (central area of photo). Irregular planar fabric is defined by segregation of comminuted debris and parallel concentration of wispy chlorite and sericite. Local shear foliation also accentuated by abundant leucoxene and locally concentrated pyrite. Plane polarised light, long dimension field of view 11 mm. Sample: MA 17K.

7. DISCUSSION OF RESULTS:

Although no additional microdiamonds other than the original commercial microdianmond chip recovered by Falconbridge Metallurgical labs have been recovered, two diamond inclusion chromites have been recovered. These chromites were recovered from the largest Mark 1 pipe and the Mark 2 pipe, that may be a (axial plane fault?) outlier of Mark 1 with most contacts covered by talus and alpine glacial sediments (Fig. 3). In fact, Dr. McCallum indicates that the Mark 1 pipe may be a part of the Mark 1X situated across the park boundary within Banff Park. Thus a very large pipe with maximum up to 250 x 1200 meters is indicated.

The diamond inclusion chromites present indicate that the Mark diatreme magma intruded a chromite hartzburgite host rock source of diamond. This is compatible with the microdiamond chip recovered by Falconbridge from a diatreme talus rock sample collected down slope from the Mark 1 and Mark 2 diatremes (Fig. 3).

Thirteen chromites and a single picroilmenite were analysed from the Falconbridge sample and many chromites and two picroilmenites were recovered and analysed from the C.F. Mineral Research Ltd processed samples. These nearly identical lamproitic heavy mineral assemblages recovered in different labs are incompatible with the possibility of the diamond chip being a contaminate. If the diamond chip had originated from a kimberlite contaminent source, chrome diopside, pyrope and other kimberlitic diamond indicator mineral contaminents should have been recovered in the Falconbridge concentrates.

Of the 48 chromites analysed from the Mark 1 diatreme from sample Mark 7, one (2%) plots in the diamond inclusion field (Fig. 6). Of the 53 chromites analysed from the Mark 2 diatreme from sample New Mark Lower, one (2%) plots in the diamond inclusion field. This compares with the two diamond inclusion chromites of 76 analysed (3%) from the diamondiferous Jack lamproite in the Golden Cluster and five diamond inclusion chromites of 198 (3%) analysed from the Prairie Creek diamondiferous lamproite, Arkansas.

The petrographic descriptions of Dr. McCallum indicate the Mark diatremes examined are lamproitic; ie. "probable olivine lamproite?". Olivine lamproite is the host rock of the Argyle diamond mine deposit as well as Prairie Creek, Jack and Ellendale diamondiferous lamproite deposit. Furthermore, the large Mark 1 diatreme is now known to contain a similiar heavy mineral

assemblage (chromite, picroilmenite, round dravitic tourmaline, ilmenite and rutile) to the aforementioned diamondiferous lamproite diatremes (Pg. 533, Part 3, G.S.C. open file report 2124, 1990).

8. CONCLUSIONS:

From the foregoing discussion, it appears that a large tonnage diamondiferous olivine lamproite pipe(s) could be present in covered and outcrop areas on the B.C. side of the Mark claims in the vicinity Mark 1 and Mark 2 diatremes. Although no additional diamonds have been recovered by the present study, two chromites of the same composition that grow with diamonds have been recovered. These diamond inclusion chromites recovered as well as the compatible mineralogies recovered by the differing labs, suggests the microdiamond chip recovered by Falconbridge from talus rock downslope from the Mark 1 diatreme originated from the Mark claims rather than as a lab contaminate.

9. RECOMMENDATIONS:

As economic diamond pipes usually have less that 1 p.p.b. by volume diamond, the collection of additional large tonnage superficial samples is warranted on the Mark 1 diatreme. The unsampled diatremes should also be sampled and analysed for microdiamonds and diamond indicator minerals. Additional petrographic work is also justified on the unsampled diatremes. The microprobe work of polished thin sections of Mark 1 minerals recommended by Malcholm McCallum (Appendix B) is justified to obtain a definitive petrographic classification of the Mark diatremes.

APPENDIX "A"

SCANNING ELECTRON MICROSCOPE ANALYTICAL RESULTS

MARK SAMPLES

ID	SAMPLE	GRAIN	DC	MINERAL	SIO2	TIO2	AL2O3	CR2O3	FEO	MNO	MGO	CAO	NA2O	K2O	NIO	NB2O5	CL
BMLT2B	180 1	1		CR	0.82	0.74	16.85	49.74	15.08	0.01	16.30	0.16	0.00	0.00	0.12	0.17	0.00
BMLT2B	180 1	2		CR	0.82	0.70	17.22	49.64	14.81	0.00	16.48	0.12	0.00	0.00	0.15	0.07	0.00
BMLT2B	180 1	3		CR	0.72	0.77	17.95	49.06	14.30	0.00	16.66	0.16	0.00	0.01	0.21	0.13	0.00
BMLT2B	180 1	4		CR	0.70	0.71	17.17	49.69	14.58	0.00	16.50	0.22	0.10	0.05	0.14	0.13	0.02
BMLT2B	180 1	5		CR	0.83	0.71	17.43	49.93	13.66	0.00	16.88	0.14	0.00	0.00	0.19	0.21	0.02
BMLT2B	180 1	6		CR	0.78	1.60	8.83	55.44	17.24	0.06	15.43	0.21	0.00	0.06	0.04	0.29	0.01
BMLT2B	180 1	7		CR	0.73	0.72	17.11	49.93	14.60	0.00	16.35	0.18	0.00	0.01	0.19	0.16	0.02
BMLT2B	180 1	8		CR	0.74	0.69	18.77	48.39	14.19	0.00	16.70	0.16	0.01	0.00	0.23	0.12	0.00
BMLT2B	180 1	9		CR	0.81	0.76	16.89	50.42	14.44	0.00	16.43	0.13	0.00	0.00	0.01	0.10	0.00
MARK7	181 6	1		CR	13.21	0.50	21.78	38.22	12.92	0.00	12.75	0.12	0.07	0.08	0.33	0.02	0.00
MARK7	181 6	2		CR	0.47	1.04	16.26	50.99	16.09	0.00	14.51	0.20	0.00	0.04	0.21	0.20	0.01
MARK7	181 6	3		CR	1.88	0.58	15.07	52.05	15.61	0.00	14.45	0.13	0.00	0.01	0.12	0.10	0.00
MARK7	181 6	4		CR	1.54	0.70	14.95	52.39	15.95	0.00	13.95	0.18	0.00	0.07	0.14	0.13	0.01
MARK7	181 6	5		CR	0.54	0.77	16.13	51.43	15.44	0.00	15.19	0.19	0.00	0.03	0.20	0.08	0.00
MARK7	181 6	6		CR	3.08	0.62	16.40	49.60	16.14	0.00	13.68	0.12	0.01	0.07	0.09	0.19	0.00
MARK7	181 6	7		CR	0.70	0.59	14.62	53.56	14.37	0.00	15.44	0.17	0.00	0.03	0.28	0.18	0.05
MARK7	181 6	8		CR	0.59	0.62	15.22	53.15	14.44	0.00	15.33	0.19	0.00	0.04	0.25	0.19	0.00
MARK7	181 6	9		CR	8.48	0.63	18.31	44.88	14.74	0.00	12.14	0.14	0.24	0.02	0.33	0.08	0.02
MARK7	181 6	10		CR	0.52	0.57	14.68	53.12	15.73	0.00	14.91	0.12	0.00	0.00	0.23	0.12	0.00
MARK7	181 6	11		CR	0.60	0.61	16.20	51.73	15.17	0.00	15.05	0.15	0.00	0.04	0.20	0.23	0.02
MARK7	181 6	12		CR	3.80	0.57	15.04	51.58	14.55	0.00	13.38	0.18	0.05	0.46	0.19	0.18	0.02
MARK7	181 6	13		CR	2.02	0.87	17.64	47.19	17.48	0.00	14.37	0.12	0.00	0.00	0.17	0.12	0.02
MARK7	181 6	14		CR	1.34	0.66	17.00	50.03	15.51	0.00	15.07	0.10	0.00	0.00	0.16	0.11	0.02
MARK7	181 6	15		CR	0.54	0.59	16.52	51.10	15.89	0.00	15.00	0.15	0.00	0.04	0.11	0.05	0.00
MARK7	181 6	16		CR	0.67	0.72	16.03	51.32	15.26	0.00	15.26	0.20	0.00	0.07	0.32	0.15	0.01
MARK7	181 6	17		CR	0.57	0.69	14.37	54.09	14.71	0.00	15.00	0.20	0.00	0.07	0.19	0.10	0.00
MARK7	181 6	18		CR	8.43	0.61	20.82	41.46	13.05	0.00	15.05	0.13	0.09	0.01	0.20	0.12	0.02
MARK7	181 6	19		CR	0.62	0.71	15.81	51.79	15.35	0.00	15.15	0.14	0.00	0.00	0.13	0.28	0.02
MARK7	181 6	20		CR	5.03	0.42	19.22	46.37	13.26	0.00	15.22	0.12	0.07	0.00	0.17	0.09	0.02
MARK7	181 6	21		CR	0.51	0.92	16.45	50.87	15.95	0.00	15.06	0.10	0.00	0.00	0.13	0.01	0.00
MARK7	181 6	22		CR	0.57	0.05	11.39	57.35	17.51	0.00	12.70	0.16	0.00	0.00	0.12	0.14	0.00
MARK7	181 6	23		CR	0.66	0.62	13.88	54.55	14.82	0.00	14.99	0.20	0.00	0.02	0.10	0.15	0.00
MARK7	181 6	24		CR	0.92	0.73	14.83	52.68	16.02	0.00	14.22	0.18	0.00	0.02	0.06	0.29	0.04
MARK7	181 6	25		CR	4.09	0.57	16.19	49.28	14.83	0.00	14.32	0.14	0.07	0.08	0.25	0.15	0.02
MARK7	181 6	26		CR	0.58	0.68	15.20	52.49	15.01	0.00	15.42	0.21	0.00	0.03	0.16	0.20	0.02
MARK7	181 6	27		CR	0.83	0.67	14.88	52.64	15.40	0.00	15.10	0.16	0.00	0.00	0.16	0.16	0.00
MARK7	181 6	28		CR	1.20	0.65	14.50	53.26	14.97	0.00	14.76	0.20	0.00	0.06	0.21	0.20	0.00
MARK7	181 6	29		CR	0.56	0.62	14.78	52.98	15.39	0.00	14.95	0.15	0.00	0.00	0.26	0.25	0.05
MARK7	181 6	30		CR	1.67	0.66	14.97	51.86	15.79	0.00	14.34	0.13	0.18	0.03	0.23	0.13	0.00
MARK7	181 6	31		CR	0.83	0.68	15.58	51.27	15.54	0.00	15.43	0.27	0.02	0.02	0.21	0.13	0.01
MARK7	181 6	32		CR	0.62	0.60	14.14	54.64	14.18	0.00	15.25	0.20	0.00	0.04	0.22	0.10	0.00
MARK7	181 6	33		CR	1.52	0.74	17.11	50.26	14.93	0.00	15.17	0.12	0.00	0.03	0.03	0.09	0.00
MARK7	181 6	34		CR	2.43	0.65	15.72	50.81	15.94	0.00	13.89	0.20	0.00	0.00	0.20	0.15	0.00
MARK7	181 6	35		CR	0.73	0.63	14.91	52.84	15.78	0.00	14.67	0.16	0.00	0.05	0.14	0.11	0.00
MARK7	181 6	36		CR	0.71	0.71	15.66	51.09	16.47	0.00	14.80	0.17	0.00	0.05	0.08	0.22	0.05
MARK7	181 6	37			26.86	0.33	29.47	20.88	9.33	0.00	12.28	0.09	0.53	0.08	0.00	0.13	0.01
MARK7	181 6	38		CR	0.70	0.61	13.93	54.75	14.45	0.00	15.08	0.17	0.00	0.01	0.00	0.26	0.04
MARK7	181 6	39		CR	0.62	0.86	15.46	50.80	17.33	0.00	14.59	0.12	0.00	0.00	0.12	0.11	0.00
MARK7	181 6	40		CR	0.73	0.49	12.67	56.98	13.22	0.00	15.31	0.20	0.00	0.01	0.16	0.22	0.00
MARK7	181 6	41		CR	5.40	0.67	17.34	47.75	14.93	0.00	13.32	0.14	0.10	0.02	0.11	0.22	0.01
MARK7	181 6	42		CR	0.65	0.65	15.04	53.03	14.51	0.00	15.57	0.12	0.00	0.05	0.31	0.07	0.00
MARK7	181 6	43		CR	0.74	0.59	13.86	54.39	14.62	0.00	15.32	0.17	0.00	0.00	0.12	0.19	0.00
MARK7	181 6	44		CR	0.48	0.09	8.42	59.88	18.89	0.00	11.94	0.13	0.00	0.00	0.00	0.13	0.04
MARK7	181 6	45		CR	3.90	0.53	15.31	51.28	15.15	0.00	12.89	0.17	0.02	0.31	0.26	0.16	0.02
MARK7	181 6	46		CR	0.71	0.32	11.24	58.60	13.51	0.00	14.95	0.21	0.00	0.06	0.18	0.21	0.00
MARK7	181 6	47		CR	1.39	0.84	16.83	50.49	15.50	0.00	14.48	0.18	0.00	0.05	0.06	0.18	0.00
MARK7	181 6	48		CR	2.76	0.77	16.11	49.62	16.52	0.00	13.55	0.14	0.00	0.13	0.17	0.24	0.00

MARK SAMPLES

ID	SAMPLE	GRAIN	OC	MINERAL	SIO2	TIO2	AL2O3	CR2O3	FEO	MNO	MGO	CAO	NA2O	K2O	NIO	NB2O5	CL
[redacted]K7	181 6	49		CR	0.60	0.62	14.01	54.63	16.03	0.00	13.77	0.12	0.00	0.03	0.10	0.09	0.01
BMLT1A	183 1	1		CR	0.49	0.60	16.16	52.27	14.39	0.00	15.57	0.17	0.00	0.01	0.13	0.18	0.04
BMLT1A	183 1	2		CR	0.55	0.88	16.30	51.16	15.36	0.00	15.31	0.15	0.00	0.02	0.06	0.18	0.04
BMLT1A	183 1	3		CR	0.57	0.76	16.72	51.09	14.73	0.00	15.57	0.11	0.00	0.00	0.20	0.22	0.01
BMLT1A	183 1	4		CR	0.57	0.86	15.41	52.38	15.32	0.00	14.91	0.21	0.00	0.00	0.19	0.12	0.02
BMLT1A	183 1	5		CR	0.49	0.83	17.46	49.91	14.70	0.00	16.43	0.12	0.00	0.02	0.04	0.00	0.00
BMLT1A	183 1	6		CR	0.54	0.75	15.28	52.96	14.50	0.00	15.41	0.18	0.00	0.05	0.22	0.12	0.00
BMLT1A	183 1	7		CR	0.64	0.74	16.55	51.62	14.93	0.00	15.07	0.19	0.00	0.00	0.06	0.19	0.02
BMLT1A	183 1	8		CR	0.61	0.82	15.27	52.65	15.36	0.07	14.62	0.25	0.00	0.03	0.25	0.04	0.02
BMLT1A	183 1	9		CR	0.71	0.78	16.35	50.18	16.13	0.00	15.09	0.19	0.00	0.02	0.30	0.23	0.02
BMLT1A	183 1	10		CR	0.55	0.77	16.43	50.06	15.63	0.00	16.09	0.12	0.10	0.02	0.09	0.11	0.03
BMLT1A	183 1	11		CR	0.59	0.69	17.31	49.83	15.56	0.00	15.42	0.16	0.00	0.02	0.19	0.20	0.01
BMLT1A	183 1	12		CR	0.81	0.75	15.77	51.91	14.82	0.00	15.39	0.16	0.00	0.00	0.24	0.14	0.02
BMLT1A	183 1	13		CR	0.59	0.73	16.77	50.90	15.17	0.00	15.36	0.18	0.00	0.00	0.10	0.19	0.00
BMLT1A	183 1	14		CR	0.64	0.78	15.98	51.58	15.59	0.00	14.80	0.18	0.00	0.03	0.28	0.10	0.03
BMLT1A	183 1	15		CR	0.61	0.84	16.03	51.33	15.53	0.00	15.12	0.14	0.00	0.02	0.22	0.16	0.00
BMLT1A	183 1	16		CR	0.58	0.79	15.61	51.83	15.99	0.00	14.77	0.18	0.00	0.04	0.03	0.18	0.00
BMLT2	183 2	1		CR	0.48	0.73	15.53	52.31	15.96	0.00	14.57	0.15	0.00	0.00	0.07	0.19	0.02
BMLT2	183 2	2		CR	0.65	0.92	16.76	49.32	17.08	0.00	14.76	0.16	0.00	0.02	0.10	0.22	0.01
BMLT2	183 2	3		CR	0.50	0.79	15.84	51.10	16.42	0.00	14.91	0.07	0.01	0.00	0.18	0.16	0.01
BMLT2	183 2	4		CR	0.53	0.71	15.47	52.30	15.72	0.00	14.81	0.21	0.00	0.01	0.04	0.18	0.02
BMLT2	183 2	5		CR	0.54	0.96	15.40	50.43	17.82	0.00	14.37	0.15	0.00	0.01	0.11	0.19	0.00
BMLT2	183 2	6			0.70	0.01	0.61	0.50	10.83	0.31	31.19	55.34	0.22	0.17	0.12	0.00	0.00
BMLT2	183 2	7		CR	1.82	0.56	14.79	52.42	15.78	0.00	13.81	0.16	0.15	0.06	0.27	0.17	0.00
BMLT2	183 2	8		CR	0.61	0.70	15.84	51.11	16.54	0.00	14.75	0.17	0.00	0.00	0.12	0.15	0.00
[redacted]T2	183 2	9		CR	0.57	0.84	15.19	52.22	16.57	0.00	14.17	0.13	0.00	0.00	0.14	0.17	0.00
[redacted]LT2	183 2	10		CR	0.48	0.92	15.14	52.43	16.14	0.00	14.57	0.14	0.00	0.02	0.08	0.08	0.00
BMLT2	183 2	11		CR	0.95	0.87	16.04	50.52	14.90	0.00	15.94	0.20	0.19	0.03	0.18	0.14	0.06
BMLT2	183 2	12		CR	0.56	0.73	15.06	52.58	15.09	0.00	15.19	0.19	0.08	0.04	0.26	0.17	0.05
BMLT2	183 2	13		CR	0.56	0.79	16.32	52.07	13.24	0.04	16.34	0.14	0.08	0.01	0.26	0.14	0.00
BMLT2	183 2	14		CR	0.62	0.80	16.32	50.64	14.81	0.00	16.04	0.19	0.15	0.01	0.18	0.21	0.01
BMLT2	183 2	15		PIL	0.55	52.72	0.88	0.34	33.09	0.13	11.97	0.00	0.00	0.00	0.01	0.32	0.00
BMLT2	183 2	16		CR	0.49	0.74	15.54	51.79	15.83	0.00	15.09	0.17	0.09	0.02	0.19	0.05	0.00
BMLT2	183 2	17		CR	0.57	0.87	15.86	50.21	16.35	0.00	15.47	0.19	0.09	0.03	0.22	0.13	0.00
BMLT2	183 2	18		CR	0.52	0.98	15.08	51.84	15.62	0.00	15.41	0.15	0.04	0.01	0.14	0.17	0.04
BMLT2	183 2	19		CR	0.57	0.73	15.29	52.28	15.09	0.00	15.56	0.20	0.00	0.02	0.16	0.10	0.00
BMLT2	183 2	20		CR	0.53	0.83	16.35	50.62	15.60	0.00	15.64	0.16	0.08	0.00	0.17	0.02	0.00
BMLT	183 3	2			1.39	90.58	0.76	0.65	2.60	0.00	0.00	0.02	0.00	0.03	0.00	3.95	0.00
BMLT	183 3	3		CR	0.61	0.87	16.43	50.74	15.75	0.00	14.94	0.19	0.00	0.03	0.25	0.18	0.02
BMLT	183 3	4		CR	0.60	0.93	16.12	49.99	17.71	0.00	14.27	0.19	0.00	0.00	0.08	0.12	0.00
BMLT	183 3	5		CR	0.54	0.65	15.14	53.55	15.72	0.00	14.02	0.20	0.00	0.00	0.13	0.04	0.00
BMLT	183 3	6		CR	0.80	0.80	15.39	51.83	16.85	0.00	13.94	0.19	0.00	0.01	0.13	0.06	0.01
BMLT	183 3	7		CR	0.71	0.76	14.35	53.12	16.49	0.00	14.01	0.21	0.00	0.03	0.19	0.10	0.03
BMLT	183 3	8		CR	0.51	0.81	14.16	53.27	16.86	0.00	13.86	0.22	0.00	0.06	0.13	0.08	0.04
BMLT	183 3	9		CR	0.57	0.66	14.67	53.45	15.29	0.00	14.86	0.17	0.00	0.03	0.23	0.06	0.00
BMLT	183 3	10		CR	0.69	0.86	16.24	51.10	16.20	0.00	14.57	0.15	0.02	0.02	0.09	0.06	0.00
BMLT	183 3	11		CR	1.17	0.69	16.35	50.61	15.02	0.00	15.56	0.19	0.05	0.08	0.13	0.15	0.00
BMLT	183 3	12		CR	0.63	0.78	14.90	53.13	15.95	0.00	14.09	0.16	0.00	0.00	0.22	0.12	0.01
BMLT	183 3	13		CR	0.46	0.84	12.78	56.10	16.67	0.00	12.48	0.15	0.00	0.07	0.31	0.12	0.01
BMLT1B	183 4	1		CR	0.52	0.77	16.09	51.87	14.81	0.00	15.47	0.13	0.00	0.00	0.20	0.14	0.00
[redacted]LT1B	183 4	2		CR	0.59	0.88	15.90	52.39	15.44	0.00	14.37	0.15	0.00	0.00	0.13	0.15	0.00
[redacted]T1B	183 4	3		CR	0.55	0.70	16.29	51.87	14.66	0.00	15.22	0.19	0.00	0.06	0.23	0.20	0.03
BMLT1B	183 4	4		CR	0.52	0.65	14.29	54.13	14.73	0.00	15.15	0.14	0.00	0.00	0.22	0.18	0.00
BMLT1B	183 4	5		CR	0.60	0.84	15.98	51.58	14.64	0.00	15.56	0.20	0.00	0.00	0.30	0.23	0.05
BMLT1B	183 4	6		CR	0.51	0.89	15.62	51.59	16.46	0.00	14.46	0.12	0.00	0.03	0.17	0.15	0.00
BMLT1B	183 4	7		CR	0.57	0.85	16.37	51.06	15.53	0.00	15.36	0.17	0.00	0.01	0.00	0.09	0.00
BMLT1B	183 4	8		CR	0.50	0.75	17.61	49.34	15.52	0.00	15.74	0.19	0.00	0.04	0.09	0.23	0.00

MARK SAMPLES

ID	SAMPLE	GRAIN	OC	MINERAL	SIO2	TIO2	AL2O3	CR2O3	FEO	MNO	MGO	CAO	NA2O	K2O	NIO	NB2O5	CL
BMLT1B	183	4	9	CR	0.56	0.79	17.57	50.32	14.41	0.00	16.00	0.09	0.00	0.00	0.15	0.08	0.03
BMLT1B	183	4	10	CR	0.54	0.76	15.80	51.92	15.73	0.00	14.89	0.13	0.00	0.04	0.04	0.14	0.00
BMLT1B	183	4	11	CR	0.64	0.70	14.32	55.18	15.15	0.00	13.46	0.16	0.00	0.02	0.12	0.20	0.04
BMLT1B	183	4	12	CR	0.63	0.84	16.73	50.58	14.71	0.00	15.80	0.20	0.00	0.00	0.27	0.19	0.04
BMLT1B	183	4	13	CR	0.66	0.68	15.35	52.54	14.94	0.03	15.22	0.16	0.00	0.02	0.22	0.14	0.04
BMLT1B	183	4	14	CR	0.72	0.69	16.89	50.67	14.80	0.00	15.51	0.20	0.03	0.03	0.34	0.11	0.00
BMLT1B	183	4	15	CR	0.72	0.78	17.02	49.61	15.33	0.00	15.77	0.23	0.00	0.04	0.30	0.20	0.00
BMLT1B	183	4	16	CR	0.63	0.84	17.00	50.57	14.62	0.10	15.67	0.21	0.00	0.00	0.26	0.10	0.01
BMLT1B	183	4	17	CR	0.72	0.69	15.93	51.95	14.71	0.00	15.53	0.14	0.04	0.00	0.12	0.16	0.01
BMLT1B	183	4	18	CR	0.52	0.88	16.14	50.15	16.88	0.06	14.72	0.19	0.00	0.05	0.22	0.18	0.00
BMLT1B	183	4	19	CR	0.73	0.87	15.64	51.11	16.27	0.00	14.74	0.18	0.00	0.00	0.28	0.14	0.03
BMLT1B	183	4	20	CR	0.63	0.78	15.36	52.85	14.98	0.00	14.74	0.15	0.00	0.02	0.27	0.20	0.01
BMLT1B	183	4	21	CR	0.62	0.79	16.01	51.68	14.92	0.00	15.27	0.22	0.00	0.00	0.16	0.30	0.02
BMLT1B	183	4	23	CR	0.57	0.69	16.90	50.84	14.59	0.00	16.00	0.11	0.00	0.02	0.21	0.03	0.02
BMLT1B	183	4	24	CR	0.67	0.67	15.23	52.82	14.39	0.00	15.74	0.18	0.04	0.00	0.18	0.09	0.00
BMLT1B	183	4	25	CR	0.57	0.65	16.93	50.47	14.62	0.00	16.09	0.15	0.00	0.05	0.35	0.12	0.00
BMLT1B	183	4	26	CR	0.55	0.87	17.04	50.56	14.76	0.00	15.76	0.18	0.00	0.02	0.17	0.08	0.01
BMLT1C	183	5	1	CR	1.24	0.78	15.83	50.49	16.28	0.00	14.63	0.24	0.04	0.13	0.24	0.10	0.01
BMLT1C	183	5	2	CR	0.58	0.93	19.31	46.70	16.23	0.00	15.60	0.17	0.00	0.05	0.25	0.17	0.01
BMLT1C	183	5	3	CR	0.47	0.77	17.14	50.41	15.01	0.00	15.75	0.17	0.00	0.00	0.20	0.09	0.00
BMLT1C	183	5	4	CR	0.59	0.83	17.53	49.49	15.26	0.00	15.81	0.17	0.00	0.00	0.20	0.13	0.00
BMLT1C	183	5	5	CR	0.55	0.81	16.72	50.75	14.57	0.00	16.19	0.18	0.00	0.02	0.07	0.14	0.00
BMLT1C	183	5	6	CR	0.73	0.71	16.95	50.40	14.66	0.00	15.88	0.15	0.14	0.02	0.22	0.13	0.01
BMLT1C	183	5	7	CR	0.77	0.68	16.46	51.10	14.61	0.00	15.85	0.21	0.00	0.01	0.16	0.14	0.01
BMLT1C	183	5	8	CR	0.58	0.77	16.49	51.41	14.94	0.00	15.47	0.14	0.00	0.00	0.13	0.06	0.00
BMLT1C	183	5	9	CR	0.55	0.80	15.40	52.61	14.89	0.00	15.33	0.10	0.00	0.02	0.20	0.10	0.00
BMLT1C	183	5	10	CR	0.63	0.73	16.81	50.22	15.14	0.00	15.92	0.16	0.00	0.03	0.16	0.20	0.00
BMLT1C	183	5	11	CR	0.59	0.43	14.79	50.03	25.85	0.68	7.20	0.12	0.00	0.00	0.17	0.12	0.01
BMLT1C	183	5	12	CR	0.59	0.72	14.99	53.11	15.49	0.00	14.57	0.17	0.00	0.02	0.09	0.22	0.01
BMLT1C	183	5	13	CR	0.66	0.81	17.29	50.58	14.92	0.00	15.20	0.16	0.00	0.05	0.08	0.22	0.02
BMLT1C	183	5	14	CR	0.58	0.69	16.82	50.91	15.19	0.00	15.30	0.11	0.00	0.00	0.20	0.16	0.03
BMLT1C	183	5	15	CR	0.56	0.70	16.53	51.09	15.16	0.00	15.58	0.18	0.00	0.00	0.11	0.10	0.00
BMLT1C	183	5	16	CR	0.65	0.55	15.99	51.76	14.88	0.00	15.62	0.14	0.00	0.03	0.10	0.27	0.01
BMLT1C	183	5	17	CR	0.58	0.63	16.39	51.40	15.29	0.00	15.04	0.18	0.00	0.01	0.26	0.19	0.04
BMLT1C	183	5	18	CR	0.57	0.81	15.39	51.71	15.54	0.00	15.47	0.20	0.00	0.02	0.14	0.15	0.00
BMLT1C	183	5	19	CR	0.59	0.60	15.69	52.45	14.54	0.00	15.49	0.21	0.01	0.03	0.27	0.10	0.01
BMLT2	183	6	1	CR	0.88	0.64	17.89	49.19	15.47	0.00	15.48	0.12	0.13	0.07	0.00	0.07	0.06
BMLT2	183	6	2	CR	0.55	0.84	16.17	50.48	15.64	0.00	15.57	0.19	0.20	0.00	0.16	0.21	0.00
BMLT2	183	6	3	CR	0.69	0.88	16.43	49.92	16.43	0.00	14.97	0.11	0.08	0.00	0.25	0.23	0.00
BMLT2	183	6	4	CR	0.58	0.75	13.42	55.93	15.61	0.17	13.07	0.21	0.00	0.03	0.13	0.08	0.01
BMLT2	183	6	5	CR	0.71	0.86	16.23	50.22	15.30	0.00	16.03	0.15	0.21	0.03	0.14	0.11	0.01
BMLT2	183	6	6	CR	0.80	0.62	16.40	50.89	15.34	0.00	15.62	0.10	0.00	0.02	0.06	0.13	0.00
BMLT2	183	6	7	CR	0.56	0.80	17.22	49.84	14.98	0.00	16.04	0.14	0.23	0.00	0.07	0.11	0.00
BMLT2	183	6	8	CR	0.63	0.87	15.82	50.53	17.52	0.00	14.15	0.23	0.04	0.01	0.14	0.04	0.01
BMLT2	183	6	9	CR	0.68	0.74	14.71	52.74	16.52	0.00	14.26	0.17	0.03	0.00	0.00	0.15	0.02
BMLT2	183	6	10	CR	0.92	0.72	13.87	54.01	16.39	0.09	13.56	0.21	0.00	0.02	0.07	0.13	0.02
BMLT2	183	6	12	CR	0.59	1.05	15.90	49.89	16.56	0.01	15.35	0.17	0.09	0.00	0.24	0.15	0.00
BMLT2	183	6	13	CR	0.57	0.94	16.34	49.35	17.39	0.00	15.09	0.13	0.04	0.01	0.06	0.09	0.00
BMLT2	183	6	14	CR	0.52	0.93	16.00	50.24	16.47	0.00	15.30	0.18	0.00	0.00	0.23	0.12	0.00
BMLT2	183	6	15	CR	0.56	0.79	16.17	49.98	16.45	0.00	15.37	0.13	0.10	0.00	0.26	0.16	0.03
BMLT2	183	6	111	CR	0.54	0.86	15.71	50.80	16.34	0.00	15.20	0.10	0.18	0.01	0.09	0.18	0.00
BMLT1C	183	7	1	CR	0.59	0.71	14.78	53.54	14.54	0.00	15.28	0.21	0.00	0.01	0.20	0.14	0.00
BMLT1C	183	7	2	CR	0.60	0.68	15.92	52.41	14.74	0.00	15.22	0.15	0.00	0.00	0.09	0.15	0.05
BMLT1C	183	7	3	CR	0.55	0.82	16.60	51.01	14.41	0.14	15.80	0.15	0.00	0.01	0.34	0.15	0.02
BMLT1C	183	7	4	CR	0.75	0.85	16.14	51.08	14.99	0.12	15.52	0.15	0.00	0.00	0.23	0.13	0.03
BMLT1C	183	7	5	CR	0.51	0.67	17.00	50.60	14.84	0.00	15.74	0.10	0.08	0.00	0.27	0.18	0.01
BMLT1C	183	7	6	CR	0.69	0.77	15.80	52.07	14.79	0.00	15.27	0.16	0.00	0.02	0.19	0.23	0.02

MARK SAMPLES

ID	SAMPLE	GRAIN	OC	MINERAL	SIO2	TIO2	AL2O3	CR2O3	FEO	MNO	MGO	CAO	NA2O	K2O	NIO	NB2O5	CL
BMLT1C	183 7	7		CR	0.60	0.78	16.04	52.07	13.98	0.00	15.84	0.26	0.00	0.02	0.20	0.19	0.00
BMLT1C	183 7	8		CR	0.63	0.66	17.88	49.38	14.48	0.00	16.22	0.16	0.00	0.01	0.38	0.16	0.05
BMLT1C	183 7	9		CR	0.63	0.36	18.98	49.90	13.31	0.00	16.17	0.14	0.00	0.01	0.23	0.24	0.02
BMLT1C	183 7	10		CR	0.62	0.90	16.98	51.04	14.49	0.00	15.36	0.17	0.00	0.00	0.26	0.17	0.00
BMLT1C	183 7	11		CR	0.50	0.74	15.14	53.05	15.38	0.00	14.67	0.14	0.00	0.00	0.27	0.09	0.03
BMLT1C	183 7	12		CR	0.53	0.81	15.22	53.15	14.46	0.00	15.26	0.17	0.00	0.00	0.17	0.22	0.00
BMLT1C	183 7	13		CR	0.56	0.73	15.42	52.26	15.61	0.00	14.86	0.12	0.00	0.00	0.28	0.11	0.05
BMLT1C	183 7	14		CR	0.41	0.82	14.34	53.87	14.96	0.00	15.02	0.21	0.00	0.06	0.16	0.13	0.01
BMLT1C	183 7	15		CR	0.51	0.78	14.96	52.72	15.66	0.00	14.71	0.17	0.00	0.00	0.21	0.26	0.03
BMLT1C	183 7	16		CR	0.47	0.61	14.69	54.46	15.37	0.00	14.02	0.13	0.00	0.00	0.16	0.10	0.00
BMLT1C	183 7	17		CR	0.55	0.82	15.84	51.87	15.78	0.00	14.72	0.17	0.00	0.00	0.11	0.11	0.03
BMLT1C	183 7	18		CR	0.64	0.69	14.21	54.38	14.60	0.00	14.95	0.26	0.00	0.06	0.17	0.05	0.00
BMLT1C	183 7	19		CR	0.49	0.60	15.27	53.24	14.98	0.00	14.89	0.16	0.00	0.04	0.19	0.12	0.02
BMLT1C	183 7	20		CR	0.93	0.76	17.24	49.73	15.03	0.00	15.75	0.15	0.00	0.03	0.15	0.19	0.04
BMLT1C	183 7	21		CR	0.58	0.67	15.52	52.92	14.00	0.00	15.78	0.19	0.00	0.03	0.15	0.16	0.00
BMLT2	183 8	1		CR	0.67	0.75	17.48	49.21	15.27	0.00	15.92	0.15	0.25	0.00	0.05	0.22	0.01
BMLT2	183 8	2		CR	0.58	0.86	16.96	50.30	14.42	0.00	16.24	0.16	0.12	0.04	0.12	0.18	0.01
BMLT2	183 8	3		CR	0.45	0.76	16.19	50.91	15.19	0.00	15.98	0.17	0.03	0.02	0.23	0.06	0.00
BMLT2	183 8	4		CR	0.55	0.76	15.76	51.69	14.96	0.00	15.79	0.22	0.00	0.00	0.14	0.12	0.00
BMLT2	183 8	5		CR	0.53	0.85	16.13	50.79	15.42	0.00	15.50	0.18	0.18	0.04	0.18	0.21	0.00
BMLT2	183 8	6		CR	0.48	0.77	14.77	52.76	15.96	0.00	14.87	0.15	0.00	0.00	0.12	0.12	0.00
BMLT2	183 8	7		CR	0.48	0.64	15.02	53.35	15.45	0.00	14.59	0.16	0.01	0.01	0.26	0.03	0.01
BMLT2	183 8	8		CR	0.54	0.60	14.56	54.02	14.31	0.00	15.68	0.14	0.00	0.00	0.02	0.11	0.00
BMLT2	183 8	9		CR	0.49	0.91	15.78	51.20	15.23	0.00	15.88	0.14	0.05	0.00	0.22	0.06	0.03
BMLT2	183 8	10		CR	0.50	0.81	15.54	51.88	14.94	0.00	15.84	0.17	0.15	0.00	0.04	0.12	0.00
BMLT2	183 8	11		CR	0.58	0.74	15.38	51.93	15.41	0.00	15.17	0.17	0.20	0.02	0.23	0.16	0.00
BMLT2	183 8	12		CR	0.50	0.81	16.76	50.23	15.17	0.00	15.90	0.19	0.07	0.00	0.25	0.13	0.00
BMLT2	183 8	13		CR	0.58	0.76	16.15	49.89	16.15	0.00	15.78	0.22	0.11	0.04	0.17	0.12	0.04
BMLT2	183 8	14		CR	0.65	0.68	14.39	53.72	14.64	0.00	15.38	0.18	0.03	0.00	0.16	0.16	0.03
BMLT2	183 8	15		CR	0.62	0.86	16.24	50.00	16.95	0.00	14.91	0.19	0.02	0.00	0.12	0.05	0.04
BMLT2	183 8	16		CR	0.75	0.92	14.19	53.36	15.69	0.00	14.60	0.19	0.03	0.01	0.17	0.07	0.00
BMLT2	183 8	17		CR	0.69	0.81	17.10	49.56	14.77	0.00	16.37	0.19	0.20	0.06	0.10	0.14	0.00
BMLT2	183 8	18		CR	0.52	0.82	15.55	52.09	15.27	0.00	15.32	0.16	0.08	0.00	0.15	0.03	0.00
BMLT2	183 8	19		CR	0.54	0.79	14.95	53.04	15.77	0.00	14.34	0.21	0.00	0.03	0.22	0.10	0.00
BMLT2	183 8	20		CR	0.62	0.61	14.48	53.21	16.10	0.00	14.25	0.13	0.06	0.01	0.29	0.23	0.00
BMLT2	183 8	21		CR	0.46	0.70	14.34	53.37	16.17	0.00	14.60	0.14	0.00	0.00	0.09	0.13	0.00
BMLT2	183 8	22		CR	0.71	0.83	15.22	51.88	15.28	0.00	15.39	0.18	0.23	0.01	0.18	0.08	0.00
BMLT2	183 8	23		CR	0.57	0.76	15.21	51.65	16.16	0.00	14.98	0.14	0.18	0.00	0.17	0.16	0.02
BMLT2	183 8	24		CR	0.52	0.89	13.92	53.68	15.88	0.00	14.61	0.10	0.06	0.00	0.24	0.07	0.02
NML	184 1	1		PIL	0.36	53.29	0.58	2.03	31.55	0.22	11.68	0.00	0.00	0.00	0.14	0.17	0.00
NML	184 1	2		CR	0.78	0.63	13.03	54.64	16.88	0.00	13.50	0.22	0.00	0.04	0.06	0.20	0.01
NML	184 1	3		CR	0.45	0.97	16.80	51.37	14.82	0.00	15.18	0.20	0.00	0.00	0.05	0.13	0.03
NML	184 1	4		CR	0.77	0.70	13.23	56.13	15.02	0.00	13.66	0.16	0.00	0.00	0.23	0.10	0.00
NML	184 1	5		CR	0.47	0.61	13.24	55.66	15.67	0.00	13.95	0.17	0.00	0.00	0.11	0.12	0.00
NML	184 1	6		CR	0.44	0.75	16.82	51.48	15.54	0.00	14.48	0.21	0.00	0.00	0.21	0.07	0.00
NML	184 1	7		CR	0.58	0.69	15.92	52.08	14.81	0.00	15.27	0.16	0.00	0.00	0.27	0.16	0.06
NML	184 1	8		CR	0.40	0.65	15.15	54.35	14.13	0.00	14.85	0.21	0.00	0.04	0.11	0.08	0.02
NML	184 1	9		CR	0.57	0.64	16.09	52.83	14.49	0.00	14.91	0.25	0.00	0.03	0.09	0.10	0.01
NML	184 1	10		CR	0.43	0.55	16.90	52.71	14.23	0.00	14.76	0.16	0.00	0.03	0.19	0.05	0.00
NML	184 1	11		CR	0.57	0.50	12.83	56.36	15.47	0.00	13.95	0.13	0.00	0.00	0.03	0.15	0.00
NML	184 1	12		CR	0.65	0.49	12.74	56.37	15.30	0.00	13.89	0.18	0.00	0.01	0.07	0.31	0.00
NML	184 1	13		CR	0.56	0.55	16.24	52.78	15.08	0.00	14.24	0.25	0.00	0.04	0.26	0.00	0.00
NML	184 1	14		CR	0.54	0.68	14.25	55.02	14.37	0.00	14.56	0.19	0.00	0.03	0.18	0.19	0.01
NML	184 1	15		CR	0.48	0.57	12.78	55.91	16.42	0.00	13.36	0.20	0.00	0.00	0.08	0.15	0.06
NML	184 1	16		CR	0.51	0.64	15.87	52.41	15.36	0.00	14.68	0.20	0.00	0.04	0.09	0.19	0.00
NML	184 1	17		CR	0.54	0.73	16.64	51.29	15.37	0.00	14.81	0.17	0.00	0.01	0.27	0.17	0.00
NML	184 1	18		CR	0.54	0.73	15.05	52.46	16.63	0.00	13.97	0.14	0.00	0.00	0.31	0.12	0.05

MARK SAMPLES

ID	SAMPLE	GRAIN	OC	MINERAL	SIO2	TIO2	AL2O3	CR2O3	FEO	MNO	MGO	CAO	NA2O	K2O	NIO	N8205	CL
NML	184 1	19		CR	0.52	0.81	16.20	51.99	15.20	0.00	14.82	0.19	0.00	0.03	0.12	0.13	0.00
NML	184 1	20		CR	0.68	0.69	13.02	55.24	16.38	0.00	13.34	0.19	0.00	0.07	0.08	0.27	0.04
NML	184 1	21		CR	0.76	0.49	13.35	55.43	14.87	0.00	14.61	0.13	0.00	0.04	0.15	0.16	0.02
NML	184 1	22		CR	0.68	0.55	17.60	50.58	15.05	0.00	15.01	0.17	0.00	0.00	0.18	0.20	0.00
NML	184 1	23		CR	0.41	0.86	14.16	54.52	16.93	0.00	12.70	0.12	0.00	0.00	0.09	0.19	0.02
NML	184 1	24		IL	0.47	45.49	0.12	0.00	46.12	4.11	3.11	0.00	0.00	0.01	0.00	0.56	0.00
NML	184 1	25		CR	0.92	0.71	13.19	54.63	17.90	0.00	12.29	0.15	0.00	0.00	0.19	0.01	0.00
NML	184 1	26		CR	0.60	0.61	16.06	52.97	14.68	0.00	14.52	0.16	0.00	0.06	0.13	0.18	0.02
NML	184 1	27		CR	0.55	0.56	12.90	55.72	16.34	0.00	13.28	0.22	0.00	0.04	0.11	0.27	0.00
NML	184 1	28		CR	0.52	0.77	14.49	54.07	15.81	0.00	13.78	0.15	0.00	0.00	0.24	0.17	0.00
NML	184 1	29		CR	0.49	0.78	15.66	53.02	14.89	0.00	14.61	0.20	0.00	0.03	0.18	0.11	0.02
NML	184 1	30		CR	0.55	0.60	13.30	55.27	15.91	0.00	13.92	0.20	0.00	0.03	0.04	0.19	0.00
NML	184 1	31		CR	0.38	0.67	15.20	52.74	16.33	0.00	14.26	0.13	0.00	0.00	0.15	0.13	0.01
NML	184 1	32		CR	0.55	0.59	13.09	55.43	16.24	0.00	13.25	0.20	0.00	0.01	0.32	0.31	0.00
NML	184 1	33		CR	0.50	0.50	13.33	55.43	15.55	0.00	14.13	0.18	0.00	0.04	0.16	0.19	0.00
NML	184 2	1		CR	0.34	0.79	16.35	52.20	15.32	0.00	14.42	0.23	0.00	0.05	0.22	0.09	0.00
NML	184 2	2		CR	0.42	0.73	15.60	53.22	14.94	0.00	14.60	0.16	0.00	0.00	0.24	0.08	0.01
NML	184 2	3		CR	0.46	0.51	12.62	56.72	15.38	0.00	13.76	0.15	0.00	0.01	0.16	0.22	0.00
NML	184 2	4		CR	0.60	0.72	15.92	52.19	15.06	0.00	14.71	0.20	0.00	0.00	0.40	0.19	0.00
NML	184 2	5		CR	0.49	0.54	12.93	55.87	16.22	0.00	13.36	0.18	0.00	0.00	0.25	0.16	0.00
NML	184 2	6		CR	1.14	0.60	11.02	57.98	15.75	0.00	12.78	0.26	0.00	0.01	0.25	0.19	0.03
NML	184 2	7		CR	0.50	0.50	12.02	57.50	14.73	0.00	14.28	0.18	0.00	0.00	0.12	0.13	0.04
NML	184 2	8		CR	0.60	0.70	7.26	62.38	14.81	0.00	13.53	0.23	0.00	0.04	0.15	0.30	0.00
NML	184 2	9		CR	0.57	0.74	13.02	55.77	14.65	0.00	14.64	0.16	0.00	0.04	0.28	0.14	0.00
NML	184 2	10		CR	0.46	0.79	15.62	53.02	14.88	0.00	14.76	0.18	0.00	0.01	0.13	0.15	0.00
NML	184 2	11		CR	0.64	0.63	16.95	50.96	15.20	0.00	14.92	0.15	0.04	0.00	0.28	0.23	0.00
NML	184 2	12		CR	0.59	0.55	13.00	56.58	14.64	0.00	13.99	0.16	0.00	0.00	0.30	0.13	0.06
NML	184 2	13		CR	0.53	0.54	16.86	52.89	14.05	0.00	14.53	0.15	0.00	0.03	0.21	0.21	0.00
NML	184 2	14		CR	0.57	0.54	16.52	52.92	14.27	0.00	14.53	0.17	0.00	0.05	0.24	0.19	0.00
NML	184 2	15		CR	0.76	0.78	15.62	52.64	15.53	0.00	14.19	0.17	0.00	0.05	0.08	0.18	0.00
NML	184 2	16		CR	0.42	0.64	15.66	52.99	15.44	0.00	14.44	0.17	0.00	0.01	0.23	0.00	0.00
NML	184 2	17		CR	0.54	0.53	18.02	50.70	14.77	0.00	14.84	0.18	0.00	0.00	0.27	0.14	0.00
NML	184 2	18		CR	0.52	0.69	13.07	55.48	16.37	0.00	13.36	0.21	0.00	0.05	0.14	0.10	0.00
NML	184 3	1		CR	0.52	0.75	16.35	52.23	14.80	0.00	14.83	0.14	0.00	0.04	0.24	0.09	0.00
NML	184 3	2		CR	0.46	0.52	12.45	56.90	15.11	0.00	13.94	0.27	0.00	0.00	0.11	0.23	0.00
NML	184 3	3		CR	0.61	0.67	15.66	52.47	15.65	0.00	14.31	0.18	0.00	0.02	0.21	0.21	0.01
NML	184 3	4		CR	1.00	0.85	14.69	53.36	16.45	0.00	12.79	0.30	0.00	0.03	0.29	0.23	0.00
MARK6	185 1	1		CR	0.56	0.82	14.39	53.41	16.03	0.00	14.28	0.17	0.00	0.00	0.13	0.17	0.03
MARK6	185 1	2		CR	0.45	0.91	13.82	53.44	16.60	0.00	14.41	0.16	0.00	0.00	0.13	0.08	0.00
MARK6	185 1	3		CR	0.53	0.91	14.16	53.47	16.05	0.00	14.47	0.20	0.00	0.00	0.08	0.12	0.02
MARK6	185 1	4		CR	0.47	0.93	14.79	51.43	16.46	0.00	15.40	0.20	0.00	0.06	0.16	0.09	0.00
MARK6	185 1	5		CR	0.64	0.93	15.29	51.66	16.16	0.04	14.58	0.10	0.00	0.00	0.36	0.22	0.02
MARK6	185 2	1		CR	0.40	0.88	16.02	51.78	16.08	0.00	14.47	0.19	0.00	0.06	0.00	0.09	0.03
MARK6	185 2	2		CR	0.53	0.72	16.51	51.47	15.90	0.00	14.49	0.16	0.00	0.02	0.20	0.00	0.00
MARK6	185 2	3		CR	0.75	0.82	15.18	51.66	16.20	0.01	14.77	0.13	0.00	0.00	0.25	0.18	0.05
MARK6	185 2	4		CR	0.73	0.80	14.88	51.81	15.84	0.00	15.15	0.17	0.00	0.04	0.39	0.19	0.00
MARK6	185 3	1		CR	0.47	0.79	14.32	53.10	16.43	0.04	14.45	0.14	0.00	0.03	0.13	0.10	0.00
MARK6	185 3	2		CR	0.58	0.81	14.63	52.62	16.60	0.00	14.39	0.14	0.00	0.00	0.09	0.15	0.00
MARK6	185 3	3		CR	0.53	0.83	15.98	50.94	16.08	0.00	14.97	0.15	0.00	0.00	0.33	0.18	0.01
MARK6	185 3	4		CR	0.68	0.86	14.43	52.48	16.61	0.00	14.39	0.20	0.00	0.00	0.11	0.23	0.01
MARK6	185 3	5		CR	0.68	0.84	16.49	49.95	16.22	0.03	15.09	0.19	0.00	0.00	0.38	0.12	0.00
MARK6	185 3	6		CR	0.50	1.49	9.14	56.42	18.20	0.00	13.60	0.19	0.00	0.03	0.20	0.23	0.00
MARK6	185 3	7		CR	0.53	0.80	15.55	51.77	16.05	0.00	14.76	0.18	0.00	0.03	0.25	0.06	0.02

APPENDIX " B"

Appendix B.

MARK DIATREMES

MARK 1 PIPE

Sample MA2

Macroscopic Description

Pale olive brown weathering, gray green "sandy" tuffisitic breccia" (db) from near the northern border (along the Range divide) of the Mark 1 diatreme. The sample site is about 7 meters south of the contact in an exposure of well foliated, moderately coarse breccia with average lithic clast sizes ranging from 5-30 cm. Sedimentary rock fragments predominate, and the strong parallel alignment of elongate clasts, and presence of abundant slip planes defined by concentrations of finely comminuted debris and wispy shreds of sericite and chlorite impart a prominent planar fabric that parallels axial plane cleavage surfaces in adjacent rocks.

Microscopic Description

This sample is a lithic clast dominated, matrix supported fragmental rock that is moderately well foliated. Lithic fragments comprise about 70% of the rock volume, and approximately 1/4 of these are greater than 4 mm. Foliation is imparted by the parallel alignment of numerous elongate clasts (especially sericitic argillites that are stretched out and contorted) and the presence of planar concentrations of wispy sericite and chlorite along with very fine grained debris including abundant leucoxene. Dolomitic rocks dominate the lithic clast population, and include fine to medium grained varieties, some of which are arenaceous (silty and sandy) and/or argillaceous. Also relatively abundant are limestone, sericitic argillite, mudstone, and sandstone with dolomitic cement. Several fragments of quartzite and sericite schist also were observed. Pressure shadows of fibrous quartz and dolomite are present at the ends (parallel to foliation) of some dolomitic rock clasts.
Hypabyssal/volcanic fragments generally are well rounded and are more abundant in the fine lapilli to ash size range. All are intensely altered, but microporphyritic vitrophyres and phlogopite lamprophyres have been tentatively identified along with tuff autoliths. Glassy groundmasses in vitrophyres are replaced by finely crystalline dolomite that has been flooded by leucoxene, but pseudomorphed microphencrysts can be recognized as olivine, pyroxene and phlogopite, suggesting that these rocks could be lamprophyres. Fine grained equigranular phlogopite bearing clasts also may be lamprophyric. These contain abundant laths (to 0.3 mm long) replaced by intensely leucoxenized, turbid, finely crystalline dolomite, and these probably were phlogopite crystals. The pseudomorphed laths are set in a groundmass of clots and irregular masses of dolomite, sericite, chlorite and orthoclase(?), with locally larger masses of subradiating bundles of sericite and chlorite. Abundant tiny grains of pyrite and leucoxenized perovskite(?) are scattered throughout.

Quartz grains constitute approximately 7% of the crystal clast population. Most quartz crystals are less than 0.5 mm across and range from well rounded to angular, the smaller size population (< 0.2 mm) being most angular. Pressure shadows of fibrous quartz and sericite occur on both ends (parallel to

foliation) of some larger quartz grains. Dolomite ± quartz pseudomorphs (to 1 mm) after olivine and pyroxene are relatively abundant, as are chloritized, sericitized and dolomitized amphibole crystals (to 1 mm long). Some amphibole clasts are completely chloritized, whereas others have cores of subradiating chlorite and rims of intermixed dolomite and sericite. Chloritized phlogopite crystals (to 0.5 mm long) are relatively abundant, and one large deformed and partially disrupted chloritized phlogopite crystal (~3.5 mm across) has lenticular dolomite penetrating along cleavage planes. Some pseudomorphed olivine clasts are rimmed by thin leucoxenized aggregates of finely crystalline anatase(?).

The groundmass of this rock consists mostly of granular dolomite with intermediate areas of finely crystalline sericite + chlorite + orthoclase(?) ± quartz. Weak to strong leucoxene flooding is pervasive and tiny grains (< 0.15 mm) of equant pyrite and leucoxenized perovskite(?) are scattered throughout.

Conclusion

This rock is a "sandy" crystal-lithic ash-lapilli tuff breccia with probable lamprophyric (amphibole-phlogopite-pyroxene-olivine lamproite?) affinity. Microprobe analyses of groundmass orthoclase(?) and least altered areas of phlogopite xenocrysts might provide useful information regarding petrologic association.

Sample MA17H

Macroscopic Description

Pale grayish green weathering, gray green "tuffisitic breccia" (db) from near the southeastern edge of the Mark 1 diatreme. The sample site outcrop is characterized by abundant rounded to subrounded blocks (to 60 cm across) of fine to coarse grained, pale to dark green, intensely altered, phlogopite lamprophyre (lamproite?). Much less common are dolomites and limestones similar to nearby sedimentary units, and a few intensely carbonatized and oxidized granitic(?) blocks were observed. The rock is moderately well foliated, the planar fabric imparted by alignment of elongate, lenticular and stretched out lithic clasts and presence of abundant chlorite and local sericite foliae that wrap around many clasts. This foliation is parallel to axial plane cleavage surfaces in the adjacent sedimentary sequence.

Microscopic Description

This sample is an olive green to gray green lithic clast dominated fragmental rock with well defined foliation. Nearly 70% of the rock is comprised of lithic clasts, and at least 3/4 of these are of igneous origin. More than half of the fragments exceed 4 mm in length (some as much as 1.5 cm long), and most have a pronounced elongation. Strong parallelism of elongate clasts coupled with mutual alignment of thin segregational zones of very fine grained clastic debris and concentrations of bundles of chlorite and wispy sericite define a prominent foliation. This planar fabric is accentuated by parallel internal flowage and shearing in some of the elongate rock fragments.

The most abundant fragments are lapilli and ash grains (many pelletal) of aphanitic to medium grained or vitrophyric, porphyritic to microporphyritic

lamprophyre. Most contain phenocrysts of olivine and pyroxene that have been replaced by dolomite ± quartz and dolomite ± chlorite, respectively. Some are amphibole and/or phlogopite rich, and these minerals have been replaced by leucoxenized chlorite ± sericite ± dolomite and chlorite ± sericite respectively. A few clasts contain sanidine, both fresh and partially sericitized and/or replaced by quartz. Groundmasses of these clasts typically are leucoxenized and consist of variable amounts of microcrystalline dolomite + sericite + chlorite + orthoclase(?). Tiny (most < 0.2 mm) leucoxenized opaque mineral grains (ilmenite?) and perovskite are ubiquitous. A few grains of chromite(?) and leucoxenized skeletal grains of ilmenite exceed 0.3 mm. Some of the groundmass chlorite, along with that in pseudomorphed phenocrysts appears to be enriched in Cr, and some of the coarsest sericite appears to be fuchsitic.

A number of well rounded clasts appear to be basalt/andesite. These have intergranular fabrics and contain abundant small plagioclase laths (altered to sericite ± dolomite/calcite ± albite) set in a groundmass of pyroxene (altered to chlorite + dolomite + goethite - limonite) and oxidized magnetite and/or ilmenite. A few of these clasts have pseudomorphed olivine and pyroxene phenocrysts. A few well rounded tuff autoliths also are present. Sedimentary rock clasts include fine grained limestone, fine to coarse grained dolomite (some with possible fossil fragments, locally dolomitized chert, and sericitic argillite. Many of these clasts have pressure shadows of fibrous dolomite + quartz and/or sericite.

Crystal clasts comprise less than 2% of the rock volume and these are mostly pseudomorphed olivine, pyroxene, amphibole and phlogopite (some fresh). They range to 0.3 mm long and may be accompanied by rounded spinel grains of similar size. A few small rounded quartz grains (most < 0.2 mm) also are present, and many have pressure shadows of fibrous quartz and sericite.

The groundmass of this rock consists of microcrystalline to cryptocrystalline dolomite + sericite + chlorite + orthoclase(?) ± quartz, and some areas are completely replaced by coarsely crystalline dolomite. Small leucoxenized grains (most < 0.1 mm) of perovskite(?), anatase(?) and opaque minerals are scattered throughout the matrix. Larger, angular, locally skeletal, leucoxenized grains (to 0.4 mm) of ilmenite are also present.

Conclusion

This rock is a lithic ash-lapilli tuff breccia (block or boulder breccia in outcrop) with probable lamprophyric (phlogopite-amphibole-pyroxene-olivine lamproite?) affinity. Microprobe analysis of fresh phlogopite, spinel, groundmass orthoclase(?) and leucoxenized opaque minerals could provide valuable information regarding petrologic association.

Sample MA17K

Macroscopic Description

Pale gray green to maroon green weathering, maroon-olive "tuffisitic breccia" (db) near the south central margin of the Mark 1 diatreme. This is a block or boulder breccia in part, containing abundant lithic clasts that range

to more than 70 cm in diameter. Mafic igneous rock fragments are most abundant, and these tend to be subrounded to well rounded. The spotty maroon-green color of the breccia is imparted by hematitization of Fe bearing minerals in mafic rock clasts. A weak foliation is defined by local alignment of elongate lithic fragments and presence of abundant chlorite and sericite along shear planes.

Microscopic Description

This sample is a lithic clast dominated fragmental rock that is locally clast supported. Rock fragments comprise at least 80% of the total volume, and about 3/4 of these are igneous. The clasts range from angular to well rounded, are as much as 2 cm in length, and more than half exceed 4 mm. A very small proportion are elongate, but these parallel a weak foliation defined by concentrations of stretched out, irregular, elongate swirly bundles and foliae of chlorite and minor sericite, with variable amounts of leucoxene and leucoxenized perovskite and/or sphene. Sedimentary rock clasts tend to be more elongate than igneous varieties, and include finely crystalline dolomite, dolomitic sandstone, siltstone, and chert, and rare quartzite. Basaltic/andesitic clasts predominate, and range from diabasic intergranular, fluidal trachytic, to vitrophyric. Phenocrysts (most < 1.0 mm) of olivine, pyroxene and plagioclase in poryphyritic varieties typically are altered and rimmed by concentrations of goethite-limonite. Although some plagioclase is moderately fresh locally, it generally is at least partially replaced by sericite and/or calcite. Femag minerals are completely replaced by fine mixtures of dolomite and goethite-limonite-hematite. Intensely leucoxenized or oxidized opaque mineral grains (probably ilmenite and magnetite respectively) are relatively abundant in these clasts. A few of the larger clasts of andesite consist of dolomitized and limonitized pyroxene phenocrysts (to 2 mm) set in a groundmass dominated by plagioclase laths (partially replaced by sericite and calcite) and completely altered interstitial pyroxene and opaque minerals. A few moderately coarse to vitrophyric fragments appear to be intensely altered lamprophyres. Coarser varieties are dominated by olivine(?) and phlogopite, whereas finer grained to glassy types contain more pyroxene and sanidine(?) with abundant oxidized spinel and leucoxenized perovskite. Olivine is completely replaced by dolomite $\pm$ quartz, pyroxene by dolomite and/or chlorite, and phlogopite and sanidine(?) are variably chloritized and sericitized respectively. Many of the phenocrysts are rimmed by intensely oxidized opaque minerals, which also are very abundant in the groundmasses which are dominated by dolomite/calcite, chlorite, sericite and orthoclase(?).

Crystal clasts comprise only a few percent of this rock. Most prominent are disrupted, irregular, phlogopite and biotite books (to 1.3 mm across) that are fresh to variably chloritized and locally partially replaced by quartz along cleavage traces. More abundant are well rounded to oblong grain (to 0.6 mm) and smaller more angular grains (< 0.2 mm) of quartz. Pseudomorphed olivine clasts (to 0.4 mm, replaced by dolomite $\pm$ quartz, fresh angular grains ($\sim$ 1 mm) of K-feldspar rimmed by dolomite and minor chlorite, subrounded chromite ($\sim$ 1 mm), and a few leucoxenized opaque mineral grains (to 1.0 mm) that probably are ilmenite and/or titanate also are present.

The groundmass of this rock is a fine grained mixture of dolomite, calcite, chlorite, minor sericite, and patchy areas of a low birefringence material that is probably orthoclase. Small grains (most < 0.06 mm) of

variably oxidized opaque oxide minerals (Magnetite?, spinel?) and leucoxenized perovskite(?) and/or sphene (most < 0.03 mm) are ubiquitous. A few small grains of apatite also were noted.

Conclusion

This rock is a lithic ash-lapilli tuff breccia (block or boulder breccia in outcrop) with probable lamprophyre (phlogopite-olivine lamproite?) affinity. Chemical analysis of unaltered phlogopite, opaque oxide minerals and K-feldspars would be useful for a more precise evaluation of petrologic association.

Sample MA17L

Macroscopic Description

Maroonish green to gray green, fine grained "sandy" "tuffisitic breccia" (db) from near the southeastern border of the Mark 1 diatreme a few meters from sample site MA17K. Lithic clasts comprise well over 50% of this rock, and moderately well rounded to elliptical hypabyssal/volcanic varieties predominate. Most rock fragments are less than 1 cm, but a few clasts are several centimeters. Opaque mineral phases in many of the igneous clasts are intensely hematitized (and/or limonitized) imparting a spotty reddish to maroon color to the rock. A moderately well developed foliation is defined by local size segregation and alignment of elongate clasts as well as the presence of abundant parallel foliae of chlorite.

Microscopic Description

This sample is a lithic clast dominated fragmental rock that is similar in many respects to sample MA17K but is much finer grained, more enriched in crystal clasts and sedimentary rock fragments, and more strongly foliated. In thin section, most of the lithic clasts are less than 4 mm although a few reach about 6 mm. Most abundant are opaque mineral rich, coarsely dolomitized clasts with scattered irregular chlorite pseudomorphs (most < 0.2 mm) of probable phlogopite. Some of these clasts also contain a few phenocrysts (to 0.3 mm) of pseudomorphed olivine and pyroxene (mostly to dolomite ± quartz ± chlorite) that are rimmed and partially replaced by limonite-goethite, and irregular to blocky orthoclase(?) crystals (to 0.15 mm) may be present in less dolomitized parts of the groundmass. Tiny leucoxenized grains of perovskite pervade the groundmasses of these clasts, all of which probably are lamprophyres. Generally strongly altered, iron oxide rich fragments of basalt/andesite also are relatively abundant, and many of these are very fine grained to vitrophyric. The sedimentary component of the lithic clast population is comprised mostly of finely crystalline dolomite and limestone (some silty), with minor amounts of dolomitic siltstone and sandstone.

Quartz grains comprise about 10% of the crystal clast population; coarser grains (to 0.7 mm) are well rounded to oblong, whereas smaller grains (< 0.2 mm) commonly are angular. Rare iron oxide (goethite-limonite) rimmed pseudomorphs of dolomite ± quartz after olivine and pyroxene, and chloritized

phlogopite are present, and a few subrounded grains (to 0.6 mm) of chromite were observed.

The groundmass of this rock is mostly fine grained fibrous to subradiating chlorite intergrown with patchy, fine to medium grained dolomite. Leucoxene is locally abundant, and tiny grains (most < 0.02 mm) of opaque minerals and leucoxenized perovskite are widely distributed.

Conclusion

This rock is a "sandy" crystal-lithic ash-lapilli tuff with probable lamprophyre (phlogopite-olivine lamproite?) affinity. Analysis of opaque mineral phases might allow the petrologic association to be more firmly established.

Sample MA17M

Macroscopic Description

Massive, dark green to greenish black weathering, green, locally sheared and brecciated, chloritized hypabyssal breccia near the south-central edge of the Mark 1 diatreme. This breccia occurs in a dike(?) that ranges to greater than 5 m thick (thickest to the southeast) and traverses the diatreme in a northwesterly direction. The dike appears to parallel foliation in the diatreme breccias and essentially separates a brown to maroon weathering phase (dbb) from the more common green weathering phase (db). The dike rock is variably sheared, fairly intensely so at and near contacts, and consists predominantly of fragments of basalt and lamprophyre? breccia (autoliths) in a generally well foliated, comminuted clast and chlorite rich matrix.

Microscopic Description

This sample is a moderately sheared, lithic clast rich fragmental rock that is intensely altered. Clasts range from subrounded to highly angular (some wedge-shaped), are predominantly igneous, and comprise more than 70% of the rock by volume. Although one angular autolith exceeds 3 cm in length, most clasts are less than 7 mm long. Basaltic clasts are typically microporphyritic, with phenocrysts of pseudomorphed olivine (most < 1.0 mm, replaced by calcite/dolomite and minor goethite-limonite) set in a pilotaxitic groundmass of altered plagioclase laths and stubby pyroxene prisms. Plagioclase is essentially completely replaced by sericite and calcite, and pyroxene is altered to chlorite with minor quartz. Magnetite and ilmenite (leucoxenized) are common accessories, and groundmass areas generally are flooded with microcrystalline leucoxene. Several coarser grained fragments contain leucoxenized skeletal ilmenite crystals (most $\sim$ 1 mm). Several ash sized basaltic(?) clasts are characterized by abundant small plagioclase laths in a leucoxenized glassy matrix. Autoliths of fine grained breccia (tuff) consist of small rounded clasts of basalt(?) and abundant clasts of pseudomorphed olivine (to 2 mm, replaced by calcite/dolomite), pyroxene (to 1.5, replaced mostly by chlorite) and phogopite(?) (to 1.5 mm, completely chloritized), in a matrix of microcrystalline matted to locally fibrous chlorite + sericite + low birefringence material (orthoclase?). A few grains

(< 0.6 mm) of rounded to angular quartz and K-feldspar(?) also are present. Tiny grains (most < 0.03 mm) of opaque oxides(?) and leucoxenized perovskite and/or sphene are common.

The groundmass of the breccia is compositionally similar to that in the autoliths, but exhibits a much more pronounced foliation than the latter. The planar fabric is defined primarily by the presence of abundant chlorite and sericite in distinct foliae and stretched out masses. The fabric is accentuated by minor segregated concentrations of leucoxene and leucoxenized mineral grains.

Conclusion

This rock appears to be an intensely altered hypabyssal breccia (crystal-lithic ash-lapilli tuff breccia) of probable lamprophyric affinity, but thin sections of additional dike samples would be needed to be more definitive. It is possible that the dike is primarily basaltic, with only limited areas of brecciation and intrusion by lamprophyric(?) material. Analysis of opaque minerals and feldspars in the breccia groundmass would be helpful to determine the possibility of a lamproitic association.

Sample MA17P

Macroscopic Description

Pale green weathering, olive gray to gray green, somewhat sandy "tuffisitic breccia" (db) in cliff face at the southern edge of the Mark 1 diatreme. The breccia is a block (or boulder) variety with abundant lithic clasts, some of which exceed 50 cm. Sedimentary and igneous rock clasts are roughly equal in abundance in the ash and lapilli population, but blocks are predominantly sedimentary rocks. A moderately well developed foliation is expressed by parallel alignment of elongate lithic clasts and irregular layers of finely comminuted debris and foliae of chlorite and sericite. Phlogopite macrocrysts (0.5 - 2 cm) are present locally.

Microscopic Description

This sample is a lithic clast dominated (~65%) fragmental rock in which sedimentary and igneous rock fragments are approximately equal in abundance. Lithic clasts range to about 1 cm and at least 25% of the total exeed 4 mm. Many clasts are elongate, especially those < 4 mm, and tend to be strongly aligned parallel to a pronounced irregular planar fabric imparted by concentrations of finely comminuted debris and well developed foliae and chlorite and/or sericite. This planar fabric is strongly accentuated in thin section by abundant finely crystalline leucoxene in zones of maximum comminution. Sedimentary rock clasts are predominantly carbonates, and most of the < 4 mm fragment population is of this composition. Both limestones and dolomites are present, they typically are rounded to subangular and range from very fine to fine and medium grained, and some are well bedded. A few dolomite fragments are arenaceous, and several carbonate clasts have pressure shadows of calcite and fibrous quartz. Several elongate clasts of sericite argillite and mudstone also are present. Igneous rock clasts typically are subrounded to

well rounded and appear to be mostly lamprophyric in composition. Most abundant is a porphyritic phlogopite-olivine rich variety that may be lamproite. These clasts are characterized by pseudomorphed olivine phenocrysts (to 3 mm) completely replaced by turbid dolomite. The phenocrysts commonly are partially rimmed and locally veined by calcite with tiny grains (most < 0.02 mm) of leucoxenized perovskite and/or sphene. Smaller phenocrysts (most < 0.3 mm) of dolomitized olivine and pyroxene and abundant chloritized phlogopite are set in a groundmass of finely crystalline dolomite + chlorite + a low birefringence phase (probably orthoclase) + fine leucoxene. Also relatively abundant are clasts of a more equigranular, coarser grained rock that is almost completely replaced by dolomite and chlorite. The chlorite occurs in scattered irregular patches that appear to be pseudomorphic after phlogopite and/or pyroxene. These clasts typically contain abundant tiny grains of leucoxenized perovskite and opaque minerals and have a lamprophyric character in handsample. Minor amounts of small, rounded, porphyritic basalt/andesite clasts also are present. Small pyroxene and olivine phenocrysts are chloritized and dolomitized respectively. Some clasts contain abundant small laths of fluidally aligned plagioclase (replaced by calcite) with intergranular pyroxene and/or glass replaced by intensely leucoxenized dolomite.

Crystal clasts comprise approximately 10-15% of this rock. Most abundant (6-10%) and most apparent are well rounded to oblong quartz grains (0.2-0.6 mm) that give the rock a somewhat "sandy" appearance. Finer grained (< 0.2 mm) quartz is less noticeable and typically is subangular to angular. Also common (3-5%) are pseudomorphed crystals (to 2 mm) of olivine and pyroxene replaced by dolomite and/or calcite. Some of the pseudomorphs are rimmed by thin aggregates of leucoxenized anatase(?). Contorted, chloritized phlogopite grains (to 2 mm) and a few subrounded spinel (chromite?) crystals (to 0.6 mm) also are present.

The breccia groundmass is a mixture of finely crystalline dolomite/calcite, chlorite, and minor sericite with variable amounts of low birefringence material (orthoclase ± quartz). Small grains (most < 0.04 mm) of leucoxenized perovskite and/or sphene are relatively abundant and scattered grains of leucoxenized opaque minerals (ilmenite?, titanate?) are present. Finely crystalline leucoxene is ubiquitous, and rare small grains (< 0.15 mm) of pyrite were noted.

Conclusion

This rock is a somewhat "sandy" crystal-lithic ash-lapilli tuff breccia (block breccia in outcrop) of probable lamprophyric (phlogopite-olivine lamproite?) affinity. Fresh opaque oxide mineral grains and groundmass orthoclase(?) should be chemically analyzed to provide data regarding petrologic association.

Sample MA17TI

Macroscopic Description

Pale brown weathering, pale gray, somewhat "sandy", "tuffisitic breccia" (db) from the west-central part of the Mark 1 diatreme. The breccia is dominated by well rounded to subangular sedimentary rock clasts, most of which

are less than 30 cm in diameter. It weathers to moderately steeply dipping slabs that are controlled by the presence of well defined slip cleavage surfaces that promote differential alteration. These surfaces are variably spaced (mms. to 10's of cms. apart) thus the rock is not characterized by a pervasive foliation.

Microscopic Description

This sample is a lithic clast dominated (> 50%) fragmental rock in which sedimentary fragments comprise about 3/4 of the total rock clasts. Most clasts are less than 4 mm across, and maximum size in thin section is 6 mm. The sample is essentially non-foliated, although elongate clasts exhibit a minor alignment, and a very weak planar fabric is present locally imparted by a few irregular zones of comminuted clastic debris with associated drawn out chlorite and sericite. The weak foliation is accentuated by abundant leucoxene and local concentrations of fine grained (0.01-0.07 mm) pyrite.

Fine, medium to coarse grained dolomites (some sandy and/or silty) dominate the lithic clast population. Many of the fragments have pressure shadows of fibrous quartz and sericite, some are partially rimmed by sericite or by less ferroan dolomite (or calcite), and some contain abundant euhedral (rhombs) dolomite crystalloblasts. Also present is dolomitic sandstone, dolomitic chert and variably sericitized dolomitic mudstone, along with minor limestone and sericitic argillite. Igneous rock clasts are predominantly porphyritic mafic vitrophyres. These are characterized by dolomitized phenocrysts (some to 1 mm) of olivine and pyroxene in a devitrified, locally dolomitized, cryptocrystalline groundmass of orthoclase(?) + chlorite + sericite + leucoxene. Some clasts contain sericitized K-feldspar or plagioclase phenocrysts, and some contain chloritized phlogopite microphenocrysts (to 0.2 mm). A few rare mafic vitrophyre(?) clasts are completely replaced by dolomite except for complex "dendritic" networks of leucoxene and minor local areas occupied by a microcrystalline, low birefringence phase (probably orthoclase). Several small, well rounded tuff autoliths also were observed. The groundmasses of all igneous clasts are typically intensely leucoxenized.

The most evident crystal clasts are well rounded quartz grains (most between 0.2 - 0.5 mm.; < 0.2 mm grains are less abundant and typically angular) that comprise about 4-6% of the rock. Olivine and pyroxene crystals (to 1.0 mm) pseudomorphed by turbid dolomite are locally prominent (several %). Some of these clasts have thin rims of calcite ($\sim$ 0.2 mm thick), and most are rather intensely leucoxenized. Subrounded, leucoxenized opaque mineral grains (> 0.5 mm; ilmenite?, titanite?) are relatively abundant, and several probable chromite grains (one 0.6 mm, others < 0.2 mm) were noted.

The breccia groundmass is mostly finely crystalline dolomite with variable amounts of microcrystalline to fine grained chlorite $\pm$ sericite $\pm$ orthoclase(?) $\pm$ fibrous quartz + leucoxene (much replacing tiny perovskite and/or sphene grains). Some areas are dominated by blocky orthoclase(?) crystals (to 0.04 mm) associated with minor amounts of chlorite and sericite, and locally replaced by 0.005 - 0.03 mm rhombs of dolomite. Other areas are dominated by mats of subradiating sericite. A few irregular grains (< 0.3 mm) of pyrite also were observed.

Conclusion

This rock is a somewhat "sandy" crystal-lithic ash-lapilli tuff (breccia in outcrop) with probable lamprophyric (olivine lamproite?) affinity. Chemical analyses of fresh opaque oxide mineral grains and probable groundmass orthoclase would be helpful in documenting petrologic association.

Sample MA17T2

Macroscopic Description

Pale brown weathering olive gray to gray, fine grained sandy tuff or grit phase interlayered with gray "tuffisitic breccia" (db) a few meters from sample site MA17T1 in the Mark 1 diatreme. Layers of this phase rarely exceed a few meters thick, average clast size is less than 2 mm, and locally pebbly horizons (rounded clasts to about 1 cm) commonly are present. Moderately well developed bedding (segregational foliation?) evident in outcrop is defined by grain size variations. Rounded quartz grains (essentially all < 1 mm) are rather evenly distributed throughout the phase giving it a "sandy" appearance. Well rounded to subangular lithic clasts and pseudomorphed pyroxene and olivine crystals also are rather evenly distributed throughout the rock.

Microscopic Description

This sample is a fine grained, heterolithic "sandy" tuff or grit (tuffaceous sandstone?). Crystal clasts are essentially equal to or slightly exceed lithic fragments. All clasts are less than 2 mm in longest dimension and range from well rounded to subangular. "Bedding" seen in outcrop is not evident in thin section, although a weak planar fabric defined by parallel to subparallel alignment of some elongate clasts and minor groundmass sericite is present. Lithic clasts are mostly less than 1 mm, subrounded to subangular, and sedimentary rock types predominate. Most abundant are varieties of dolomite (especially fine grained types) many of which are sandy, silty, and/or argillaceous. A few limestone fragments also were observed. Igneous clasts tend to be somewhat more rounded (commonly pelletal) and include minor elongate, deformed dolomitized and leucoxenized vitrophyres, some of which are microporphyritic with dolomitized olivine and pyroxene microphenocrysts (< 0.3 mm). A few small pelletal tuff autoliths also were noted.

Well rounded to oblong quartz clasts (most < 0.5 mm) are the most prominent crystal clast component of the rock, and those greater than 0.01 mm comprise more than 15% volumetrically. Smaller grains (< 0.2 mm) typically are more angular; larger grains commonly have pressure shadows of fibrous quartz and sericite. Dolomitized pyroxene crystals are abundant and dolomitized olivine also is present. Both types typically are rimmed by fine leucoxene, and pyroxene pseudomorphs generally have interiors dusted by leucoxene. A few pyroxene/olivine pseudomorphs are partially rimmed by fine grained (< 0.01 mm) pyrite. Intensely sericitized clasts of K-feldspar are common locally, as are angular dolomite clasts (to 0.4 mm) that are partially replaced by microcrystalline dolomite along their borders. One well rounded dravite(?) crystal ($\sim$ 0.25 mm) was noted.

The groundmass of this sample consists mostly of finely crystalline to microcrystalline dolomite, with local areas of fibrous microcrystalline quartz, and variable amounts of fine grained sericite, chlorite, and probable orthoclase. Leucoxene is pervasive, and abundant tiny, equant leucoxenized grains (< 0.02 mm) probably are perovskite and/or sphene. A few leucoxenized opaque mineral grains probably are ilmenite and/or titanates. Small euhedral grains (< 0.25 mm) of pyrite are distributed sporadically throughout the sample.

Conclusion

This rock is a "sandy" lithic-crystal ash tuff of probable lamprophyric affinity. Similarity of components to other phases in the diatreme suggest a probable lamproite association. Additional useful petrologic information could be established from chemical analyses of fresh opaque oxides, groundmass orthoclase(?), and the single observed grain of dravite.

MARK 2 PIPE (Western Outlier? of Mark 1 Pipe)

Sample MA11

Macroscopic Description

Brown weathering, olive gray "tuffisitic breccia" (dbb) from near the northern edge of the Mark 2 diatreme, a small tabular body that may be an erosional remnant of a once more extensive Mark 1 pipe. The body lies parallel to well developed axial plane cleavage in the host sedimentary units, and is penetrated by a mutually parallel foliation defined by a general alignment of elongate lithic clasts and presence of local zones of irregularly curviplanar concentrations of wispy, drawn out sericite with fine grained clastic debris and finely crystalline leucoxene. The rock is lithic clast rich, most of which are sedimentary lithologies and fragments averaging about 2-15 cm (some exceed 1 m). Coarser clasts are typically subangular to subrounded, whereas smaller clasts tend to be more rounded. Igneous rock clasts are relatively sparse, tend to be more concentrated in the smaller clast population, and are all extremely altered. Most are fine grained hypabyssal and/or volcanic varieties. A few clasts (to 1 cm) of chloritized phlogopite were observed in outcrop.

Microscopic Description

This sample is a fragmental, locally clast supported, non-foliated rock comprised of greater than 80% lithic clasts. In thin section, rock fragments range to 1.3 cm, at least 25% exceed 4 mm, and most are subrounded to subangular. Sedimentary types are most abundant, especially dolomitic varieties that range from fine to coarse grained and locally contain relict fossil fragments. Sericitic mudstones and silty argillites also are present along with cherty rocks that have been locally replaced by irregular masses and scattered rhombs (to 0.3 mm) of dolomite. Hypabyssal and/or volcanic rock fragments are much less abundant, generally smaller, and typically well rounded (many as pelletal lapilli and ash grains). Most common are microporphyritic

vitrophyres (possibly lamprophyric) in which small, dolomitized microphenocrysts (most < 0.2 mm) of olivine and pyroxene are set in a turbid, intensely leucoxenized glassy matrix. A few clasts are comprised of dolomitized olivine and weakly sericitized to fresh sanidine(?) phenocrysts (to 0.5 mm) in a groundmass that is completely replaced by fine granular dolomite flooded with leucoxene. Two finely dolomitized microporphyritic clasts also contain euhedral pseudomorphs (to 0.7 mm long) of amphibole replaced by mats of microcrystalline chlorite which in turn is locally replaced by dolomite. A few clasts consisting of relatively coarse, multi-sized crystalline dolomite flooded by leucoxene, typically contain irregular, leucoxenized opaque mineral grains (to 1 mm across) that may be ilmenite or titanomagnetite. These clasts may be peridotites in which relatively coarse silicate phases have been completely dolomitized.

Crystal clasts comprise a small proportion of this rock, and most abundant are dolomite pseudomorphs (most < 0.4 mm) after olivine and pyroxene. A few of these are rimmed by thin aggregates of spinel(?) (titanomagnetite?) and/or anatase. A few chloritized amphibole clasts are present along with randomly scattered well rounded grains (< 0.5 mm) of quartz. Several equant chromite(?) crystals (to 0.4 mm) also were observed.

The "breccia" groundmass consists mainly of fine to medium granular dolomite that is weakly to moderately flooded by leucoxene. Pyrite grains, commonly euhedral and as much as 0.4 mm across, are scattered throughout the matrix, and some tiny grains (< 0.02 mm) are associated with leucoxenized opaque minerals (ilmenite?, titanite?). Some larger pyrite grains are characterized by pressure shadows of fibrous quartz and sericite. Some interclast areas apparently were open at some time and this space was filled by moderately coarse dolomite (crystals to < 1 mm), commonly with granular quartz in central regions.

Conclusions

This rock is a clast supported, lithic lapilli tuff breccia of possible lamprophyric (olivine lamproite?) affinity. Although a definitive petrologic association can not be established, the apparent presence of clasts of olivine, pyroxene, amphibole, and phlogopite are compatible with a lamprophyric source. Useful chemical data might be obtained by analyzing groundmass opaque oxides and sanidine phenocrysts in lithic clasts.

MARK 4 PIPE

Sample MA16A

Macroscopic Description

Coarse, brown weathering, olive gray "tuffisitic breccia" (dbb) from the northern edge of the tabular Mark 4 breccia mass. The rock exposed at this site is lithic clast dominated and might best be termed a block (or boulder) breccia. Rock fragments are mostly sedimentary types (especially dolomitic varieties), are predominantly greater than 6 cm and range to greater than 1 m. Despite the coarse nature of the breccia, it contains a moderately well

developed planar fabric defined by alignment of elongate clasts, locallized segregation of smaller sized clasts, and presence of wispy sericite in irregular zones of finely comminuted debris.

Microscopic Description

This sample is a fragmental, largely clast supported, weakly foliated (locally) rock that is composed of greater than 80% lithic clasts. rock fragments range from well rounded to angular and more than half volumetrically are larger than 4 mm. Several exhibit minor to appreciable disruption, and numerous fractures in a large clast ($\sim$ 2 cm) of dolomitized siltstone are healed by dolomite. Fine grained to coarsely crystalline, commonly arenaceous and locally fossil bearing dolomite varieties predominate as clasts, along with dolomitic siltstones and mudstones (some of which are sericitic). Minor argillites, generally sericitic, comprise the bulk of the most elongated fragments, and a single slightly dolomitized quartzite clast was observed. Igneous rock fragments are restricted to the finer grained clast population and are relatively uncommon compared to sedimentary varieties. They are typically well rounded, intensely altered, and basic hypabyssal and/or volcanic in character. Despite the high degree of alteration, relict fabrics where preserved suggest that the igneous clasts are mostly andesite/basalt with a few microporphyritic vitrophyres of probable lamprophyric affinity. Crystal clasts comprise only about 1% of the rock, and rounded to angular quartz grains (to 0.5 mm in diameter, most < 0.2 mm) account for most of the population. However, a few rare pseudomorphs of dolomite after olivine were observed.

Although this sample is essentially non-foliated, a weak, local irregular penetrative fabric is imparted by the presence of thin zones (most < 0.3 mm wide) enriched in drawn out sericite, chlorite, leucoxene and fine grains (most < 0.02 mm) of pyrite and leucoxenized perovskite(?) that bend around rock fragments. The groundmass consists mostly of finely granular dolomite, with minor microcrystalline sericite, chlorite, and locally fibrous quartz, and is moderately flooded by cryptocrystalline leucoxene. Some interclast areas are filled with relatively coarse (to > 0.6 mm), commonly bladed dolomite intergrown locally with granular quartz or fibrous quartz and sericite.

Conclusion

This sample is clearly a clast dominated fragmental rock best referred as a lithic lapilli-tuff breccia. However, at the outcrop scale it would be better termed a lithic lapilli-block (or boulder) breccia. Little evidence is available in this sample to establish a petrologic affinity for this apparently "intrusive" breccia, although its similarity to nearby breccias that exhibit lamprophyric affinity suggests a comparable association.

Sample MA16C

Macroscopic Description

Brown weathering, pale olive "sandy" "tuffisitic breccia" (dbb) from the east-central part of the tabular Mark 4 breccia mass. The rock in outcrop is characterized by abundant subangular to rounded sedimentary rock clasts that

average about 5-20 cm but may exceed 1 m. A few well rounded mafic igneous rock fragments are present in the < 20 cm clast population. The breccia exhibits a well developed outcrop scale planar fabric defined by aligned elongate rock fragments and the presence of differentially spaced zones of slippage that parallel axial plane cleavage planes in adjacent rocks and which are characterized by concentrations of fine clastic debris and wispy sericite and chlorite.

Microscopic Description

This sample is a fragmental rock with similar components to those present at nearby sample site MA16A, but lithic clast size and concentration is smaller, igneous rocks and crystal clast concentration is higher, and foliation is better developed. A weakly developed but pervasive planar fabric is imparted by the alignment of elongate and stretched lithic clasts and is accentuated locally be the presence of wispy elongate aggregates of sericite and/or chlorite both commonly flooded by leucoxene. Lithic clasts comprise about 60% of this rock and most are less than 4 mm across. Dolomitic varieties predominate, ranging from finely to coarsely crystalline and locally arenaceous or cherty. Variably dolomitized sandstone, siltstone, chert and sandy chert are relatively abundant as is sericitic argillite. A few fragments of quartzite also are present. Hypabyssal and/or volcanic rock clasts are mostly basaltic/andesitic and basic vitrophyric varieties. Many of the former exhibit diabasic textures and plagioclase laths in some are unaltered. However, most are moderately to intensely altered with little to no primary material preserved, and are typically flooded by leucoxene. Some basalt/andesite clasts are characterized by turbid glassy matrices, but most vitrophyric clasts typically contain altered olivine and pyroxene microphenocrysts, occasional sanidine(?) phenocrysts, and lack plagioclase. The groundmass of these vitrophyres is intensely leucoxenized and glass(?) has been replaced by microcrystalline dolomite with minor amounts of sericite, chlorite, and a low birefringence material that may be orthoclase. These rocks may be lamprophyric.

Rounded to subrounded quartz grains (to ~ 0.6 mm, most < 0.4 mm) comprise the bulk of the crystal clast population and along with smaller grains (< 0.2 mm) that are mostly angular to subangular account for nearly 10% of the rock volume. Dolomite pseudomorphs (to 0.6 mm long) after olivine and pyroxene are moderately abundant, and a few elongate pseudomorphs (0.4 - 0.6 mm long) composed of leucoxenized finely crystalline dolomite are probably after amphibole. Several rounded chromite grains (to 0.6 mm) and a few leucoxenized rounded opaque mineral grains (probably ilmenite) were noted. Some angular sanidine grains (to 0.5 mm) also are present.

The groundmass of this sample consists predominantly of fine to medium grained dolomite replacing a low birefringence, blocky, microcrystalline material that is probably orthoclase. Also present are variable amounts of matted and isolated tiny grains of sericite and chlorite, all flooded by leucoxene. Tiny, equant, intensely leucoxenized grains (most < 0.02 mm) of perovskite(?) are disseminated throughout the groundmass, and a few small crystals of pyrite were observed.

Conclusion

This rock is a somewhat "sandy" crystal-lithic lapilli-ash tuff (ash-lapilli tuff breccia in outcrop) of probable lamprophyric (olivine lampoite?) affinity. Opaque oxide mineral grains, sanidine clasts, and groundmass orthoclase(?) should be analyzed to better evaluate the petrologic association of this rock.

MARK 5 PIPE

Sample MA14

Macroscopic Description

Brown weathering, dark gray slightly "sandy" "tuffisitic breccia" (dbb) from near the northern edge of the tabular Mark 5 breccia mass. This rock is very similar in outcrop to that in the Mark 4 pipe at sample site MA16C. It is a moderately coarse sedimentary rock clast dominated breccia, with a well developed regional planar fabric that parallels axial plane cleavage in the host sedimentary sequence. Foliation is imparted by parallel alignment of elongate lithic clasts, and the presence of narrow shear planes where very fine grained clastic debris and wispy shreds of sericite and chlorite are concentrated.

Microscopic Description

This sample is a fragmental, matrix supported rock that is very similar to sample MA16C except that it exhibits essentially no foliation and contains fewer rounded quartz clasts. Sedimentary rocks dominate the lithic clast population which comprises about 35% of the sample. Clasts range from angular to subrounded and most are less than 4 mm (largest is 8 mm long). Dolomitic varieties (finely to coarsely crystalline; some arenaceous, argillaceous and/or cherty) are most abundant, but sericitic argillite, and variably dolomitized siltstone, mudstone and chert also are present. A few cherty fragments contain abundant kerogen parallel to bedding. Although rare, a few fragments of well rounded microporphyritic vitrophyre and tuff autoliths are present. The groundmasses of both clast types are intensely dolomitized and leucoxenized, the latter property making these fragments very recognizable in reflected light. Altered microphenocrysts in the vitrophyres include olivine, pyroxene, and sanidine, and these rocks are probably lamprophyric (lamproitic?) in character.

Quartz is the most important crystal clast mineral, and well rounded to angular grains constitute about 5% of the rock volume. Most of the quartz clasts are less than 0.5 mm in diameter, but angular grains typically are less than 0.15 mm across. Tiny euhedral zircons (< 0.04 mm) were observed in several of the larger rounded quartz grains. Dolomite pseudomorphs after olivine (some rimmed by thin aggregates of leucoxenized anatase) are moderately common and a few sericitized sanidine(?) clasts were observed. Several leucoxenized skeletal opaque mineral grains (to 0.4 mm) were noted, and probably are ilmenite.

Most of the groundmass is an interlocking aggregate of finely granular, leucoxenized dolomite, with scattered, slightly larger (0.05 - 0.01 mm) euhedral dolomite crystalloblasts. The dolomite is locally intergrown with microcrystalline quartz and minor small crystals of sericite and/or chlorite.

Conclusion

This rock is a somewhat "sandy" crystal-lithic lapilli-ash tuff (ash-lapilli tuff breccia in outcrop), and probably has a lamprophyric (olivine lamproite?) affinity. Sanidine(?) and opaque mineral oxides should be chemically analyzed to provide possible evidence of petrologic association.

Sample MA15

Macroscopic and Microscopic Description

Brown weathering, gray "tuffisitic breccia" (dbb) from near the southern edge of the Mark 5 breccia mass. In outcrop, this rock is very similar to that at sample site MA14. Although a well developed planar fabric is evident at the outcrop scale, the thin section sample exhibits no foliation.

The sample is a matrix supported fragmental rock that contains about 35% lithic clasts, most of which are less than 4 mm, although one angular dolomite fragment is 1.5 cm across. Sedimentary clasts are most abundant and varieties of dolomite (fine to coarse grained, arenaceous, argillaceous, and/or cherty) predominate. A few fragments of locally dolomitized sandy chert and siltstone also are present. Hypabyssal and/or volcanic rocks comprise about one-third of the lithic clast population, and these typically are well rounded. They include basalt/andesite, lamprophyric(?) vitrophyres and tuff autoliths, and all are extensively altered as are similar clast types in sample MA14. Crystal clasts comprise only a few percent of the rock volume, and rounded to angular quartz grains (most < 0.4 mm) are most abundant (2%). Dolomite pseudomorphs after olivine and pyroxene although relatively common, constitute less than 1% of the total rock.

The groundmass consists primarily of fine granular dolomite with minor microcrystalline sericite and chlorite. Leucoxene flooding of the groundmass is pervasive, as is the case for matrices of mafic rock clasts. Tiny pyrite grains (to 0.2 mm) are scattered randomly throughout the matrix, and are locally concentrated within a few irregular veinlets of dolomite that cut across the groundmass. Some pyrite is concentrated with irregular aggregates (1.0 mm across) of magnetite in an area of coarse dolomite and local patchy sericite along the margin of a finely crystalline dolomite clast.

Conclusion

This rock is a lithic lapilli-ash tuff (ash-lapilli tuff breccia in outcrop) and appears to have a lamprophyric (olivine lamproite?) affinity. There is little fresh material available that could be analyzed to provide data of significance to the petrologic association of this rock.

APPENDIX "C"

STATEMENT OF EXPENDITURES

30 - NOVEMBER - 90

DIA MET MINERALS LTD.
1675 POWICK ROAD
KELOWNA, B. C.
V1X 4L1

INVOICE RE: SEM ANALYSIS ON MARK SAMPLES (MARK 7, NEW MARK & BIG MARK TALUS)

	C$
Binocular microscope picking - (Big Mark Talus 2) 2 hrs. @ $20.00/hr.	40.00
Making 3 polish sections @ $75.00/each	225.00
14 SEM scans - 7 hrs @ $120.00/hr.	840.00
Completing SEM analysis on 281 grains - @ $13.00/each	3,653.00
Fusing - 20 mesh diamond concentrate fraction - 60 ,hrs. @ $20.00/hr plus $44.00 chemicals & materials	1,332.00
Binocular microscope examining +20 mesh heavy diamond concentrate & -20 mesh (fused) diamond concentrate - 6 hrs. @ $28.60/hr.	171.60
3 hrs, Sem @ $120.00/hr.	360.00
3 Days thin section descriptions by Malcolm McCallum at $400.00/day (US)	1,425.00
Report writing by C. Fipke - 1 day @ $350.00/day (US)	415.63
Report typing, proof reading, copying of materials	300.00
Sub Total	$8,762.23
Project mamagement of Norms Manufacturing - 10%	876.22
Total	$9,638.45
Remove from PAC Account of Dia Met	$1,161.55
Total Costs	$10,800.00

APPENDIX " D "

STATEMENT OF QUALIFICATIONS

RESUME OF CHARLES FIPKE

1966 Graduated from Kelowna Secondary School. Was a Queens Scout with Bushmans Thong & Gold Chord.

1966 - 70 Completed undergraduate and graduate work at the University of British Columbia which resulted in graduation with a BSc. in Honors Geology. Worked summers on geochemistry and as a geologist's assistant for Amax Exploration (Smithers area, BC), Atlas Exploration (Yukon) and the Geological Survey of Canada (N.W.T.).

1970 - 72. Worked as a geologist in New Guinea and Irian Barat for Kennecott Copper on porphyry copper exploration using heavy mineral approaches. Mapped the geology of limonite leach capping and the alteration of the OK Tedi porphyry copper, Papua, New Guinea.

1973 Worked as a mineral geologist for Samedan Oil in North Queensland, Australia completing regional mapping and detailed geophysics - geochemistry and diamond drilling of a Mo-W deposit area. Completed some heavy mineral exploration work for scheelite.

1974 Worked as a geologist, in charge of the Barberton Division (staff of 60), for Johannesburg Consolidated Investments, South Africa. Completed geological heavy mineral exploration and geological mapping and diamond drilling for Sb & massive Cu-Ni and Cu-Zn sulfides in Barberton, South African Southwest Africa, Rhodesia and Botswana. Completed heavy mineral development and orientation research in all of the foregoing areas. Visited the underground and open pit operations of DeBeers at the Finch Diamond Mine and the Kimberley diamond mines.

1975 Worked as a geologist for Cominco involving management and logging of diamond drilling of Mo and Cu-Mo deposits if British Columbia. Worked for Cominco Research as a research geologist on heavy mineral orientation and heavy mineral research and was responsible for setting up Cominco's's heavy laboratory and procedures. The report based on Fipke's heavy mineral results was distributed world wide.

From 1977 Worked as a geologist for Cominco in Brazil in charge of exploration for Pb-Zn in carbonate rocks. Used stratigraphic and heavy mineral exploration and Orientation techniques to discover Pb-Zn deposits in the Proterozoic Bambui of Minus Gerais.

1977 - 86 Founded C.F. Mineral Research Ltd. Obtained patents for heavy mineral processing techniques in Canada, the United States, Australia, and South Africa. Completed

other research projects funded by the National Research Council Step program which led to obtaining a patent in Canada for an acid leach process. Coordinated and assisted in the design of a heavy mineral and conodont laboratory unique to the Western world. Managed and coordinated a 1.4 million dollar exploration program for Superior Oil which led to the discovery of 34 kimberlite and lamproite diatremes, 18 gold deposits, two massive sulfide target areas and a new scheelite discovery in the Rocky Mountains of British Columbia and the Mackenzie Mountains, NWT. Managed many other diamond exploration field and laboratory programs in Arkansas, Colorado, Wyoming, Utah, Kansas, Idaho, Montana and California with a staff of up to 36 persons. The Fipke methods of heavy mineral geochemistry are taught in an advanced geochemistry course at U.B.C. Fipke has given many heavy mineral talks to geologists of major corporations and universities. Fipke and other CFM staff operate Canada's first commercial (windowless) scanning electron microscope that is set-up using South African standards to completed diamond indicator mineral chemistry, unique microdiamond scans and a trace element enhancement techniques for gold exploration.

1986 - 89 Completed gold, platinum and diamond heavy mineral consulting assignments for the United Nations in Peru, for Sigma Resources in New Zealand, the Geological Survey of Canada, in Sweden, in France, for Westmont Mines in Mexico and Dia Met Minerals Ltd. in British Columbia, and Northern Canada. Coordinated a recently completed $300,000 diamond exploration technology program to enable exploration companies to utilize the most advanced technology available to successfully explore for diamondiferous kimberlites and lamproites. The later (+1,300 page) project funded by the Geological Survey of Canada involved world leading diamond experts such as Dr. John Gurney, Dr. Rory Moore, Dr. Malcolm MacCallum, Dr. Barbara Smith etc.

CERTIFICATE

I, Malcolm E. McCallum of the Department of Earth Resources, Colorado State University, Fort Collins, Colorado 80523, hereby certify that:

1. I am a Professor of Geology at Colorado State University where I have been employed in a teaching and research capacity since 1962.

2. I hold degrees in Geology from Middlebury College (A.B., 1956), the University of Tennessee (M.S., 1958) and the University of Wyoming (Ph.D., 1964).

3. I have worked as a WAE research geologist (part time) for the U.S. Geological Survey on structural, petrologic, geochemical, and minerals related (emphasis on precious metals) programs in the Rocky Mountain region (New Mexico, Colorado, Wyoming, and Montana) from 1956 - 1983.

4. I have been involved in kimberlite-diamond related research since 1964, said research having been funded by a variety of agencies including the National Science Foundation, the Wyoming Geological Survey, the CSIR of South Africa, the Winston Foundation, and several companies.

5. I have been involved in research and/or field trips related to kimberlite and/or lamproite occurrences in North America (Colorado, Wyoming, Arizona, Montana, Kansas, Kentucky, Tennessee, British Columbia, Alberta); Africa, (S. Africa, Lesotho, Swaziland, Botswana, and Namibia), Western Australia and Venezuela. I also have been involved in diamond placer evaluation in Venezuela and Guyana, and have visited placer operations in Africa.

6. I recognized the presence of kimberlite in the Colorado-Wyoming Province in 1964, was instrumental in the discovery of numerous kimberlite occurrences therein, and with colleagues, in 1975 announced the recovery of diamonds from kimberlite in the Colorado-Wyoming State Line District.

7. I have conducted several short courses and seminars dealing with kimberlite-lamproite mineralogy, petrology, geochemistry and exploration, as well as other diamond related topics.

8. I am a fellow of the Geological Society of America and the Mineralogical Society of America, and a member of the Mineralogical Association of Canada, the American Association for the Advancement of Sciences, the Geochemical Society, the International Association of Geochemistry and Cosmochemistry, the Society of Exploration Geochemists, the Colorado Mining Association, the Rocky Mountain Association of Geologists, the Colorado Scientific Society, the Denver Region Economic Geology Society and Sigma Xi.

Signed M. E. McCallum

Dated at Fort Collins, Colorado, November 13, 1989.