The Buffalo Head Hills Kimberlite Province, Alberta

D. N. Skelton[1], B. Clements[1], T.E. McCandless[1], C. Hood[1], S. Aulbach[2], R. Davies[2], L.P.Boyer[3]

1. Ashton Mining of Canada Inc., Unit 123-West 1st Street, North Vancouver, V7P 3N4, BC Canada
2. GEMOC National Key Centre, School of Earth Sciences, Macquarie University, NS 2109, Australia
3. Mineral Deposit Research Unit, Department of Earth and Ocean Science, The University of British Columbia, 6339 Stores Road, Vancouver, V6T 1Z4, BC Canada

1. Introduction

The Buffalo Head Hills region is located approximately 350 kilometres north of the city of Edmonton in north-central Alberta (Figure 1). A joint venture consisting of Ashton Mining of Canada Inc., EnCana Corporation (formerly Alberta Energy Company Ltd) and Pure Gold Minerals Inc. discovered the first kimberlites in the region in early 1997 and exploration efforts since that time have led to the identification of a new diamondiferous kimberlite province in Canada. Prior to 1997, the Mountain Lake pipe, located 200 kilometres to the southwest, was the only reported kimberlitic rock in Alberta (Leckie et al., 1997, Figure 1). To date, 37 kimberlites have been discovered, at least 24 of which are diamond-bearing (Figure 2). The surface dimensions of bodies range from one to over 40 hectares and they are dominated by kimberlite volcaniclastic rocks. Mantle xenolith and diamond inclusion studies suggest that the underlying lithosphere is Paleoproterozoic in age and primarily lherzolitic in composition. Samples in excess of ten tonnes have been collected from five kimberlites, with the most encouraging results being from the K252 kimberlite where a 22.8 tonne sample yielded an estimated diamond content of 55 carats per hundred tonnes ("cpht") (Table 1).

The field trip will include visits to surface exposures of two of the largest kimberlites in the Buffalo Head Hills Kimberlite Province, K5 and K6. These bodies are inaccessible to vehicles during the summer and transport will be by helicopter from the joint venture's exploration camp located approximately ten kilometres southeast of the bodies (Figure 2). The K5 kimberlite occurs as a dramatic topographic high with an estimated surface area of over 40 hectares. The K6 kimberlite is a geophysically complex body located 500 meters southeast of the K252 kimberlite. At the exploration camp, field trip participants will be given presentations on kimberlite geology and geophysics, exploration methods and local Quarternary geology.

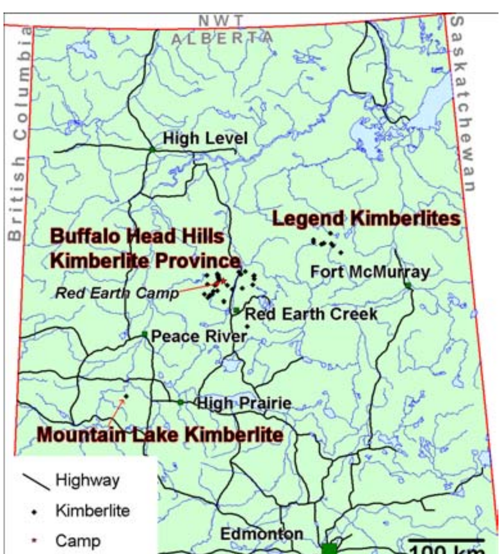

Figure 1 The Buffalo Head Hills kimberlite province location map.

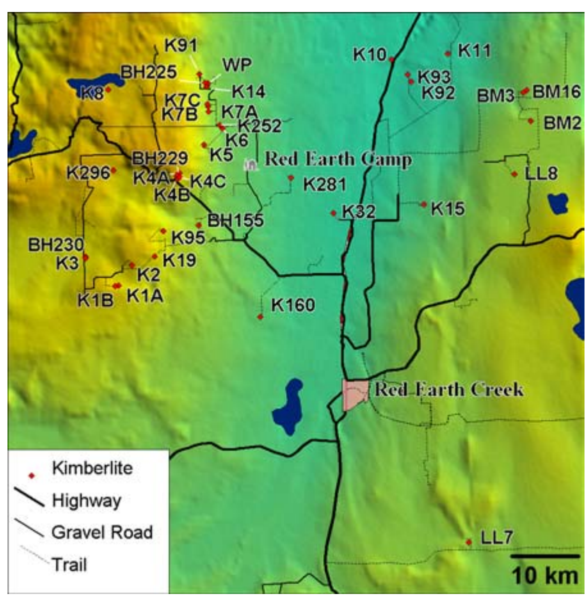

Figure 2 The Buffalo Head Hills kimberlite province with a coloured topography background.

2. Regional Geology

The Buffalo Head Hills region is underlain by Early Proterozoic basement rocks which are overlain by Phanerozoic sedimentary rocks of the Western Canada Sedimentary Basin. The basement rocks are included within the Buffalo Head Terrane of Ross (1990) and the Red Earth granulite domain of Burwash et al. (2000) (Figure 3). The Buffalo Head Terrane as defined by Ross (1990) is a broad region of generally north-trending positive curvilinear aeromagnetic anomalies. A wide range of rock types are present including felsic-to-intermediate metaplutonic rocks, felsic metavolcanics and high-grade gneiss. Zircon ages obtained from drill core range from 2.324 to 1.993 Ga including four occurrences of metaplutonic rocks in the narrow range of 1.999 to 1.993Ga. These data prompted Ross (1990) to suggest that the Buffalo Head Terrane was formed between 2.0 and 2.32 Ga and was affected by a widespread 1.9-2.0 Ga thermal-megnetic event. Burwash et al. (2000) defined the Red Earth granulite domain as an elliptical area centred on Red Earth Creek that underwent granulite-facies metamorphism. Paleozoic and Mesozoic sediments up to 5000 metres thick overlie the basement (Mossip and Shetsen, 1994). In the Buffalo Head Hills region, the Phanerozoic section is approximately 1500 metres thick and consists of Cretaceous clastic sediments overlying Devonian carbonates. The uppermost units are Early and Late Cretaceous mudstones and sandstones ranging in age from 80 to 100 million years. The local bedrock consists of the Smokey, Dunvegan, Shaftsbury and Wapiti Formations (Eccles et al., 2001). Commercial oil and gas deposits have been exploited from several of the Phanerozoic units. The entire region was glaciated during the Laurentide ice advance and its retreat deposited a complex sequence of till, lake sediment and glaciofluvial sediment up to 200 metres thick (Fenton, 1984). The Peace River Arch, an east-northeast-trending asymmetrical structure that extends from the British Columbia border on the west to northeastern Alberta on the east, is the dominant structure in the area (Cant, 1988, Figure 3). It experienced a complex history of uplift and subsidence between the Cambrian and the Cretaceous. Significant faulting related to the Peace River Arch has been identified in both the basement and overlying Phanerozoic sediments in seismic data. Faulting in the region, manifested as graben and scarp features, is thought to have influenced kimberlite emplacement (Eccles et.al., 2001).

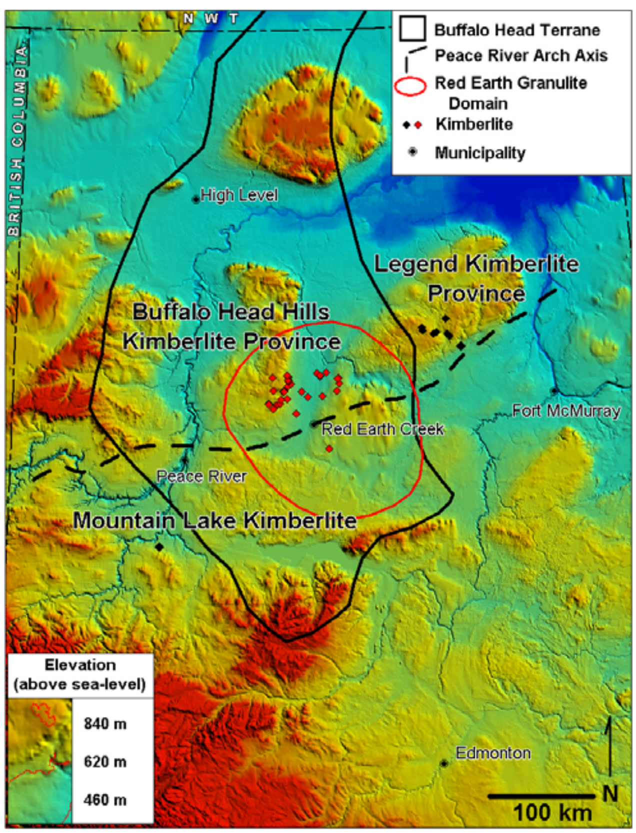

Figure 3 Prominent basement features in the Buffalo Head Hills area (modified from Ross et al., 1991, Burwash et al., 2000 and Cant, 1988).

3. Exploration

In 1995 Alberta Energy Company ("AEC") completed a regional aeromagnetic survey in the region to aid in structural interpretation. Close inspection of the total field profile data revealed a number of distinct, high frequency anomalies that were not related to basement features (Carlson et al., 1999). After consulting the literature and seeing that the Alberta Geological Survey had recovered kimberlitic indicator minerals in the region, Robert Pryde, a geologist at AEC became convinced that these features were kimberlites. In 1996 AEC acquired the mineral permits covering the most prominent of these features. After acquiring the mineral permits, they began searching for a partner with diamond exploration expertise to assist in exploring the ground for kimberlites. Ashton examined the geophysical data and was also convinced that the features could be kimberlites. In late 1996 a diamond exploration joint venture between Ashton, AEC and Pure Gold Minerals Inc. was formed. The discovery of diamondiferous kimberlites during the initial drill program in 1997 prompted extensive exploration that has included regional airborne geophysical surveys followed by helicopter-borne and ground geophysical surveys, heavy mineral sampling, drilling and kimberlite mini-bulk and bulk sampling. The initial drill program resulted in 11 kimberlite discoveries, eight of which contained diamonds. Drilling to date has identified 37 kimberlites through the testing of 77 targets. All of the drill targets were generated through geophysical exploration techniques. The first 34 kimberlites were discovered following aeromagnetic surveying as these kimberlites display a marked magnetic susceptibility contrast to the sedimentary host rock. The kimberlites are generally expressed as distinct anomalies with a wide variation in magnetic remnance (Figure 4). The K252 and K296 kimberlites are virtually non-magnetic and were identified through electromagnetic techniques. The conductive, clay-rich bedrock in the Buffalo Head Hills region contrasts sharply with the more resistive kimberlitic rocks. Gravity and seismic methods have also been used as effective exploration tools for detecting kimberlite bodies in the Buffalo Head Hills. Gravity surveying on a limited number of kimberlites produced well-defined, positive Bouger gravity anomalies (Figure 5). Where available, archived seismic data in close proximity to kimberlites show gaps in horizontal reflectors and diffractions. The K281 kimberlite was initially investigated as a seismic anomaly (Figure 6). A coincident magnetic low associated with K281 was originally thought to be cultural in origin due to the extensive oil field development in the area. Anomalous concentrations of indicator minerals are present in till samples collected down-ice of the kimberlites (Dufresne et al., 1996). One 25 kilogram till sample collected west of the K4 kimberlite yielded 152 pyrope garnet grains (Fenton and Pawlowicz, 1997).

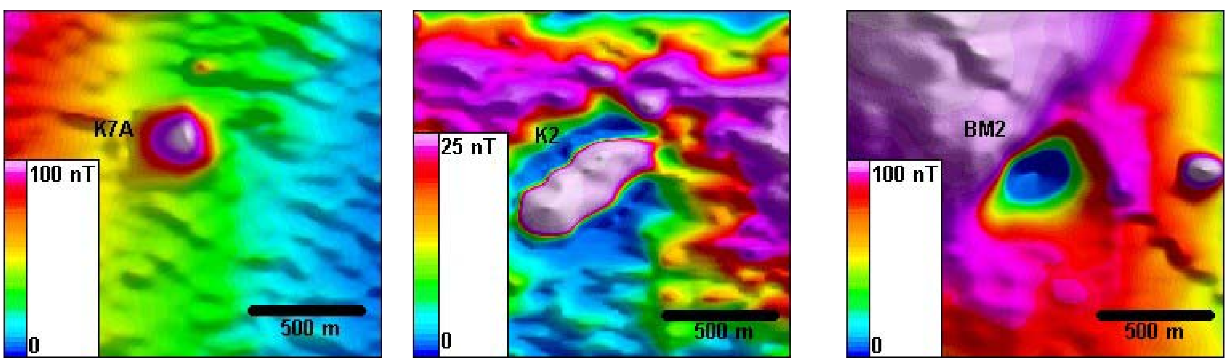

Figure 4 Helicopter-borne magnetic anomalies associated with three Buffalo Head Hills kimberlites, K7A, K2 and BM2. Note the variation in magnetic remnance.

4. Diamond Testing

Samples weighing ten tonnes or more have been collected from five kimberlites (Table 1). The best diamond result received to date is from the K252 kimberlite. K252 is buried under 65 to 80 metres of glacial overburden and exhibits two distinct phases: an upper fine- to medium- grained volcaniclastic kimberlite unit and an underlying kimberlite breccia. The kimberlite was discovered in early 2000 and favourable initial diamond results prompted the collection of a 1.28 tonne sample later in the year (Table 2). The 1.28 tonne sample of volcaniclastic kimberlite returned a total of 0.85 carats of diamonds larger than 0.8 mm using a square aperture screen.. The largest diamond recovered weighed 0.36 carat. In 2001, a 22.8 tonne sample was collected from three reverse circulation drill holes.

The larger sample returned 12.54 carats of diamonds for an estimated diamond content of 55.0 carats per hundred tonnes (Table 3). The largest diamond, a 0.94 carat colourless composite srystal, came from the breccia. The second largest diamond, a colourless 0.65 carat stone, was recovered from the volcaniclastic phase. Additional work is not planned for K252 at this time as the results of a delineation drilling program in early 2002 confirmed the kimberlite is likely less than two hectares in size.

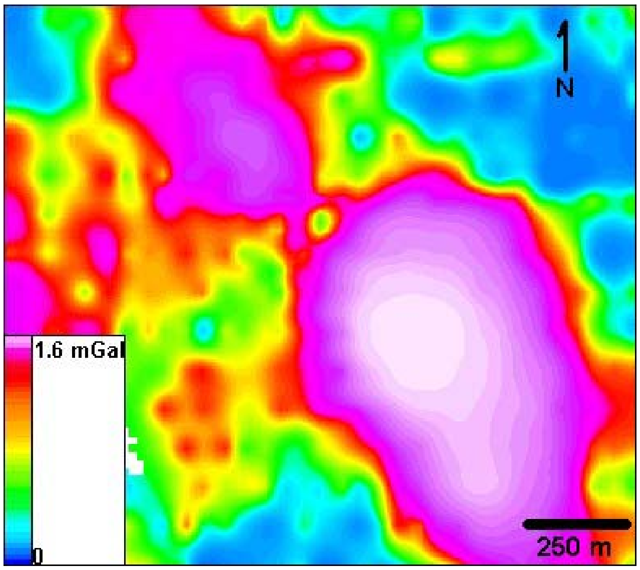

Figure 5 Ground gravity response associated with the K6 and K252 kimberlites.

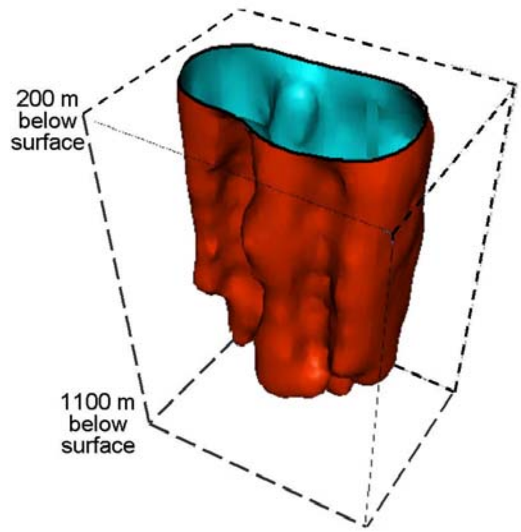

Figure 6 Seismic model of the K281 kimberlite generated from a 3D seismic survey by Alberta Energy Company Ltd.

Table 1. Diamond Results Summary for Samples > 10 Tonnes

	Mini-Bulk (Diamonds > 0.8 mm)					**Bulk (Diamonds > 1.2 mm)**
	K6	**K11**	**K14**	**K91**	**K252**	**K14**
Tonnes	13.95	21.85	44.87	35.87	22.8	479.0
Diamonds(ct)	0.88	0.96	7.79	4.56	12.54	56.45
Content(cpht)	5.6	4.4	17.0	12.7	55.0	11.7
Largest Stones	0.76	0.10	1.31	0.45	0.94	0.90
(ct)		0.09	0.60	0.41	0.94	0.88

Table 2. K252 Microdiamond Summary

Kimberlite Type	Sample Weight (kg)	Diamonds	
		Micro (0.1-0.5 mm)	Macro ≥ 0.5 mm (one dimension)
Breccia	102.7	126	7 (Note 1)
Volcaniclastic	124.2	118	12 (Note 2)
Total	**226.9**	**244**	**19**

Notes:
1. Four diamonds measured greater than 0.5 mm in two dimensions with the two largest stones measuring 2.35 x 2.19 x 0.63 mm and 2.45 x 1.70 x 0.45 mm.
2. Six diamonds measured greater than 0.5 mm in two dimensions, with the two largest stones measuring 1.60 x 0.68 x 0.46 mm and 1.32 x 1.02 x 0.37 mm.

Table 3. Summary of K252 Mini-bulk sample Results

Kimberlite Type	Calculated Sample Weight (tonnes)	Diamonds Recovered (>0.8 mm) (carats)	Diamond Content (cpht)
Volcaniclastic	13.4	4.51	33.7
Breccia	9.4	8.03	85.4
Total	**22.8**	**12.54**	**55.0**

5. Kimberlite Geology

The 37 kimberlites in the Buffalo Head Hills kimberlite province are distributed over a 6000 square kilometre area. Kimberlite outcrops have been identified in four locations while overburden up to 127 metres thick overlies other kimberlites. Size estimates based on geophysical modeling and drilling range from less than one to approximately 40 hectares. With the exception of one body, the kimberlites can generally be described as volcaniclastic olivine-rich kimberlites with varying amounts of lapilli and xenoliths. The BM2 body is interpreted as a hypabyssal kimberlite. Two types of kimberlite morphology have been identified, steep-sided, pipe-like bodies and tabular features with no known feeder. Interspersed mudstone intervals in numerous pipes could reflect either syndeposition or the presence of caved blocks of bedrock at the pipe margin. The phenocryst mineral suite includes olivine, phlogopite, spinel and perovskite. A variety of xenocrystic minerals are present in the kimberlites; olivine is the dominant mineral followed by chromite, peridotitic and eclogitic pyrope garnets and rare picroilmenite. Xenoliths are common with country rock such as mudstone, sandstone and limestone dominating. Xenoliths of basement and mantle material are present but rare.

Isotopic model age determinations on groundmass perovskite suggest the kimberlites are contemporaneous with the host rock sediments. The ages determined for K5, K7A and K14 are 88± 5Ma, 86± 3 Ma and 87± 3 Ma respectively. U-Pb isotope analysis of perovskite was performed by Geospec Consultants Ltd. The analytical data are presented in Table 4.

Table 4. U-Pb Isotope Analysis Summary for K5, K7a and K14

Kimberlite	Weight (mg))	U (ppm)	Th (ppm)	Pb (ppm)	$^{206}Pb/^{204}Pb$	$^{238}U/^{204}Pb$	$^{206}Pb/^{238}U$	1σ	Age (Ma) $^{206}Pb/^{238}U$	2σ
K5	0.022	68	175	17	30.554	875.9	0.01369	0.00036	87.6	4.6
K7A	0.075	80	4733	25	32.699	1052.8	0.01342	0.00020	86	2.6
K14	0.033	114	318	24	30.022	841.4	0.01362	0.00025	87.2	3.2
K14	0.019	113	227	20	31.885	986.3	0.01350	0.00022	86.5	2.8

5.1 Kimberlite Mineralogy and Mineral Chemistry

Indicator mineral assemblages have been assessed from 26 of the 36 kimberlites (Hood and McCandless, 2003). Forsteritic olivine constitutes over 95% of the minerals recovered from the heavy mineral concentrates. Chromian pyrope and chromite are also important constituents in most kimberlites. Eclogitic pyrope-almandine, titanian pyrope, chromian augite/diopside, and picroilmenite are also present in lesser amounts, and some bodies contain chromian corundum, zircon, edenitic amphibole, and Mg-Cr-Al spinel.

Pyrope garnet in all of the kimberlites is typically calcic and associated with a lherzolitic or wehrlitic paragenesis. Lherzolitic trends are slightly less calcic and more chromium-rich for the northerly, more diamond-rich bodies including K14, K6, K5, and K252. Higher Ca garnet is more abundant in the southern and southeastern part of the kimberlite province. Diamond content within the province can be correlated with Cr content in pyrope, particularly with the presence of very high-Cr, knorringitic garnets in bodies such as K14 and K252 (Figure 7). Many of the southern bodies, and those proximal to the axis of the Peace River Arch (see Figure 3) have low diamond contents and contain compositionally restricted, low-Cr pyrope.

Chromite compositions parallel the garnet trend, with the northern group exhibiting a trend of increasing Cr with decreasing Mg, and coincident increasing Cr and Mg for bodies in the south and southeast (Figure 8). Eclogitic pyrope-almandine and Ti-pyrope are found in many bodies. Picroilmenite occurs sporadically throughout the southern and eastern bodies, with high Nb_2O_5 content in ilmenite from barren or low-grade kimberlites such as K1A and K2.

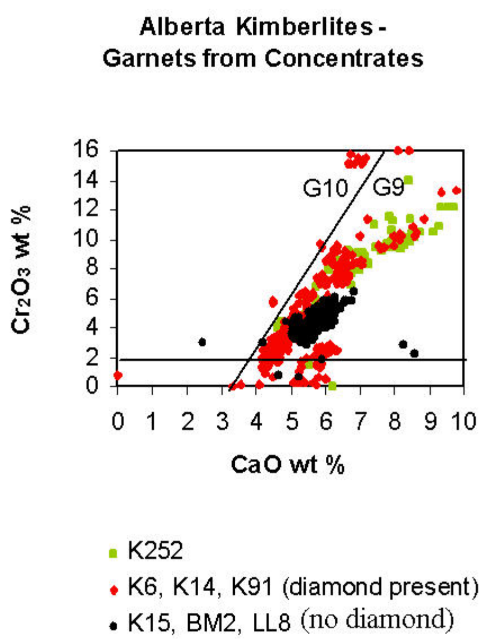

Figure 7 Garnet compositions in CaO-Cr_2O_3 space, with the lherzolitic trend indicated by the angled line from Gurney (1984).

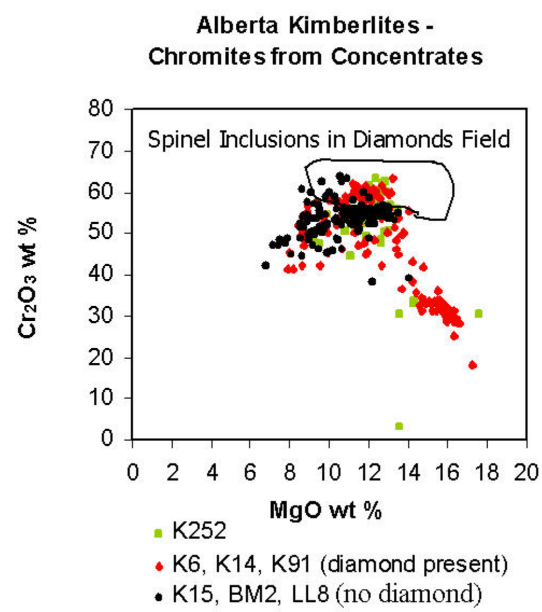

Figure 8 Chrome spinel compositions in MgO-Cr_2O_3 space relative to the spinel inclusions in diamonds field from Fipke et al. (1995).

5.2 Mantle Xenoliths

A total of 30 mantle xenoliths from the K6, K11 and K14 kimberlites was investigated for their major- and trace-element composition in order to place constraints on the nature, origin and evolution of the lithospheric mantle beneath the Buffalo Head Hills Kimberlite province (Aulbach et al., 2003). Two major series are present, a peridotite series and a pyroxenite series. The peridotites include spinel lherzolite, garnet-spinel-lherzolite, calcic garnet harzburgites and sheared garnet lherzolite. The spinel lherzolites are mostly medium-grained rocks with equant to tabular granoblastic microstructure. The three calcic garnet harzburgites are inferred to have been orthopyroxene-bearing before alteration, and have medium- to coarse-grained equant to tabular microstructure. The sheared garnet lherzolite has a mosaic-porphyroclastic foliated microstructure. The pyroxenites include garnet-bearing and garnet-free varieties. Many pyroxenites contain accessory sulfide and/or rutile. The geotherm at the time of kimberlite eruption can be constrained as equivalent to a surface heat flow of 42 mW/m^2. This is similar to present-day surface heat flows in cratonic areas. Re-Os model ages obtained in situ from sulfides in two peridotites give model ages of 1.73 ± 0.13 Ga and 1.89 ± 0.38 Ga, suggesting that lithosphere formation took place in the Proterozoic. In the 'Boyd-diagram' of modal olivine versus olivine Mg-number, the xenoliths plot in the Proterozoic field, consistent with these ages (Figure 9; Aulbach et al., 2003).

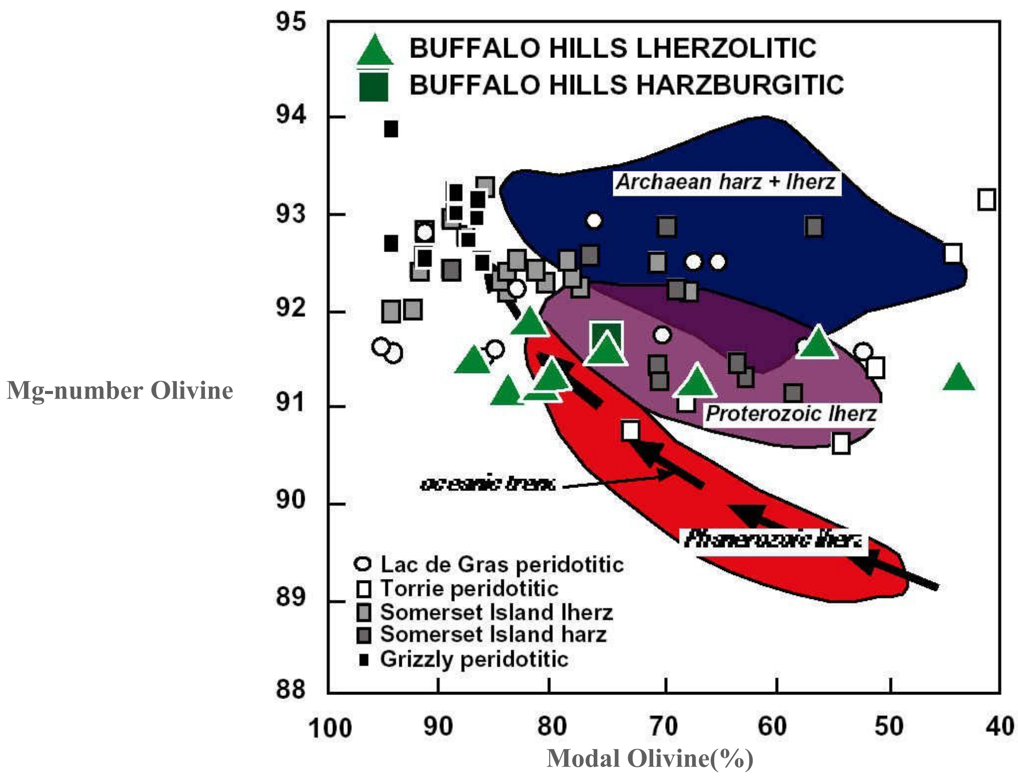

Figure 9 Xenolithic compositional trends from the K6, K11, and K14 kimberlites, compared to peridotite suites from the Slave craton (modified from Aulbach et al., 2003)

5.3 Diamond Inclusions

Analyses of mineral inclusions, carbon isotopes, nitrogen contents and nitrogen aggregation states for thirty diamonds from the K10 and K14 Buffalo Head Hills kimberlites have identified diamonds of the peridotitic (46%), eclogitic (42%), websteritic (8%) and ultradeep (4%) parageneses (Davies et al., 2003). Websteritic clinopyroxene inclusions share features with both eclogitic and peridotitic clinopyoxenes. Ultradeep diamonds host inclusions of ferropericlase and eclogitic majorite. The presence of ultradeep diamonds and mixed eclogitic-websteritic, peridotitic-websteritic and eclogitic-ultradeep associations suggests diamond growth over a range of depth and in a variety of mantle environments including the Transition Zone and Lower Mantle.

6. K5 Kimberlite

The K5 kimberlite was discovered in 1997 during the initial drill program. The magnetic anomaly associated with the body is irregular in shape and is the largest in the kimberlite province with an estimated size of 40 hectares (Figure 10). The main magnetic response is coincident with an isolated topographic high situated on the slope of the Buffalo Head Hills plateau. Field observations and drilling suggest that glacial erosion shaped K5 into a crag and tail feature. The ice direction is assumed to be from the northeast, resulting in a steeply sloped stoss end on the north side and a gradually tapering lee tail to the south (Figure 11). Kimberlite outcrop is present in a natural clearing near the center of the magnetic anomaly.

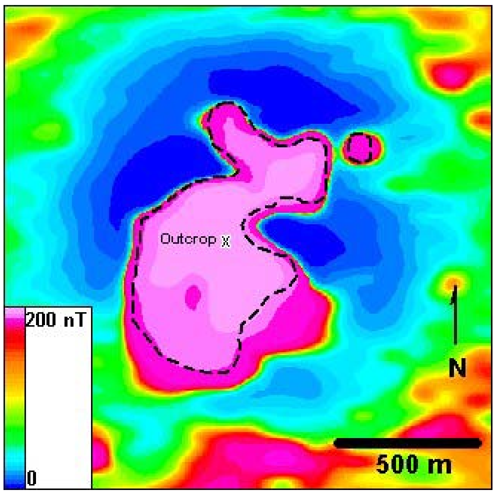

Figure 10 Airborne magnetic data with the approximate outline of the K5 kimberlite

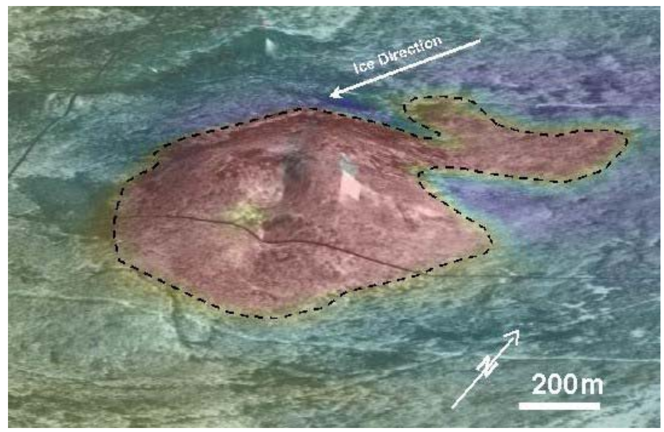

Figure 11 Airphoto of K5 with a semi-transparent airborne magnetic drape. The ice direction is from the north east.

A total of 12 core holes was drilled into K5 from five setups (Figure 12). All of the drill holes intersected volcaniclastic kimberlite and terminated in mudstone. A vent or conduit has not been located. Originally, the topographic high was thought to represent a remnant kimberlite “cone”, however it is apparent from the drilling that the kimberlitic material intersected to date was deposited or draped over an existing topographic high. The kimberlite is similar in age to the underlying mudstone bedrock of the Shaftsbury Formation. U-Pb isotope dates from micro-phenocrystal perovskite indicate the age of emplacement is 87.6 Ma. The underlying mudstone exhibits variable bedding attitudes from 0 to 60 degrees at the contact and then becomes horizontal at depth indicating distortion related to volcanic processes.

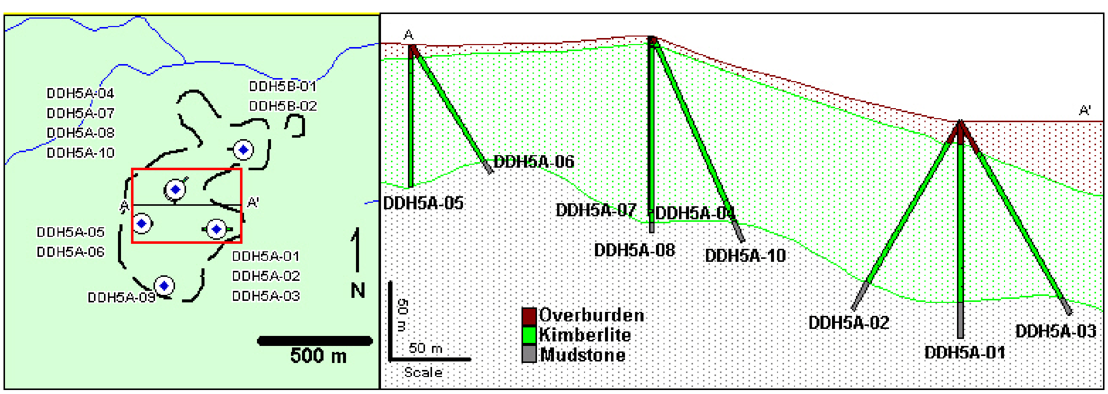

Figure 12 K5 drill hole location plan and K5 composite cross section looking north.

K5 is classified as a fine-grained, olivine-rich volcaniclastic kimberlite and is composed primarily of olivine grains and juvenile lapilli in an interclast matrix of serpentine and carbonate. The olivine grains are generally clast-supported and consist of pseudomorphed olivine macrocrysts and phenocrysts. Grain size is predominately <0.5 mm with a small population of grains in the 2-3 mm size range. Lapilli are common but variable in concentration and occur as either rounded or amoeboid forms up to 10 mm in size. The lapilli consist of fine-grained olivine phenocrysts in a glassy matrix of serpentine-like material. Carbonate-filled vesicles are internal to some of the lapilli. Xenoliths are limited to country rock lithologies such as shale and limestone and are up to 2 cm in size with the majority being less than one centimetre. The xenoliths are angular and are typically confined to the more coarse-grained beds. The presence of xenoliths in the coarse-grained units gives these units a weakly brecciated texture. Fabric or bedding can also be defined by elongated xenolithic fragments. Individual beds are generally less than 10 centimetres thick. The beds dip at 10 to 20 degrees and are well defined by grain size variations.

Initial diamond testing on over 1200 kilograms of material returned 245 diamonds with seven of those being over 0.5 mm in at least one dimension. A further 7.56 tonnes of K5 was processed by dense media separation and a total of 0.03 carats of diamond was recovered. Although pyrope garnet is not common in K5, geochemical analyses are typical of diamondiferous bodies in the Buffalo Head Hills kimberlite province.

7. K6 Kimberlite

The K6 kimberlite was discovered in outcrop in 1997. The outcrop is coincident with a small, prominent hill located at the north end of the body (Figure 13). The initial drilling tested a magnetic anomaly with approximate surface dimensions of 8.5 hectares. The anomaly consists of two convergent positive responses, a high frequency northern anomaly coincident with the outcropping area, and a more broad southern anomaly (Figure 14). Drilling confirmed the presence of volcaniclastic kimberlite at both the north and south locations. Results of a gravity survey completed in 2002 suggest that the kimberlite is not well-defined by the magnetic data alone, particularly in the southern area (Figure 5).

Drill hole locations and a cross section for K6 are presented in Figure 15. Overburden depths ranging from 0 to 13 m were encountered over the northern magnetic anomaly. This contrasts sharply with overburden depths of approximately 80 meters for the southern anomaly. The geology at K6 is variable, with continuous kimberlite intersections to 200 m in the north and mudstone intervals both within and below kimberlite in the south. The initial interpretation was that of a main kimberlite pipe or vent and a peripheral apron deposit. Recent geophysical and petrographic observations have challenged this model, suggesting the possibility of two separate kimberlite bodies. Evidence to support this model includes the definition of two gravity centres and the identification of textural differences between the southern and northern kimberlite intersections.

K6 is classified as a medium- to coarse- grained, juvenile lapilli-bearing, olivine-rich volcaniclastic kimberlite. Olivine phenocrysts and macrocrysts comprise 40 to 60 percent of the rock while lapilli constitute 30 to 50 percent. The texture is clast-supported with an interstitial matrix of carbonate and serpentine. Bedding features are difficult to distinguish, however, elongate xenoliths define a weak fabric in places. Sorting is evident in many areas where only one size fraction of kimberlitic material is present. The xenolith component is dominated by shale; crustal and mantle clasts are also common. Shale xenoliths show deformation and embayment typical of soft sediment deformation suggesting that some of the surrounding country rock was not consolidated at the time of kimberlite emplacement. Flow alignment of opaque minerals in the shale is also consistent with soft sediment deformation around the olivines. Spherical and amoeboid juvenile lapilli have been observed, some of which contain round to slightly irregular carbonate-filled vesicles and aligned phenocrysts in a fine-grained, serpentine-carbonate matrix. The phenocrysts are often concentrically oriented and increase in size towards the outside edge of the lapilli. The juvenile lapilli can reach 3 cm in diameter. Small lapilli also occur in some areas as fine rims on olivine phenocrysts. Some of the lapilli are broken indicating the material had undergone reworking. The thin sections presented in Figure 16 illustrate some of the textural features associated with K6 (Boyer et al., 2003).

Textures in the northern portion of the K6 kimberlite are relatively homogeneous. This contrasts with the south where grain size varies considerably, juxtaposing fine-grained sections with coarse breccias. Xenoliths of both mudstone and mantle derived material are very common in the brecciated portions. The lapilli throughout the southern intersections contain phenocrysts of perovskite in concentration of up to 20 modal percent.

Diamond testing at K6 has included caustic fusion and dense media separation analyses. A total of 681 kilograms of material was treated by caustic fusion, resulting in the recovery of 99 diamonds <0.5mm and 9 diamonds >0.5mm and <2mm. Reverse circulation drilling, core drilling and trenching on the shallow northern portion of K6 has resulted in the collection of 19.6 tonnes of material. The 19.6 tonne sample returned 1.41 carats of diamond for an estimated diamond content of 7.6 cpht (Table 1). The largest stone was a 0.76 carat yellow diamond.

Figure 13 K6 kimberlite outcrop.

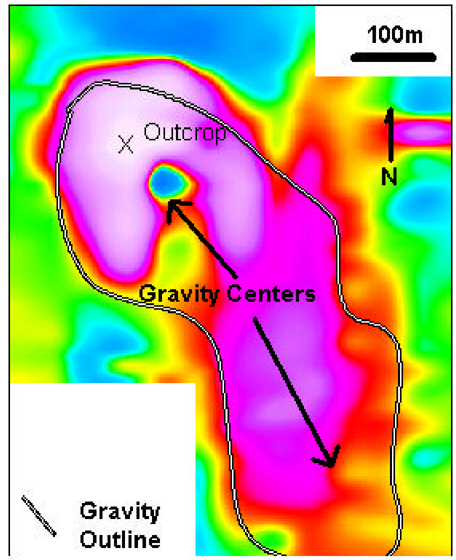

Figure 14 Magnetic data for K6 with the approximate outline of the kimberlite defined by gravity modeling.

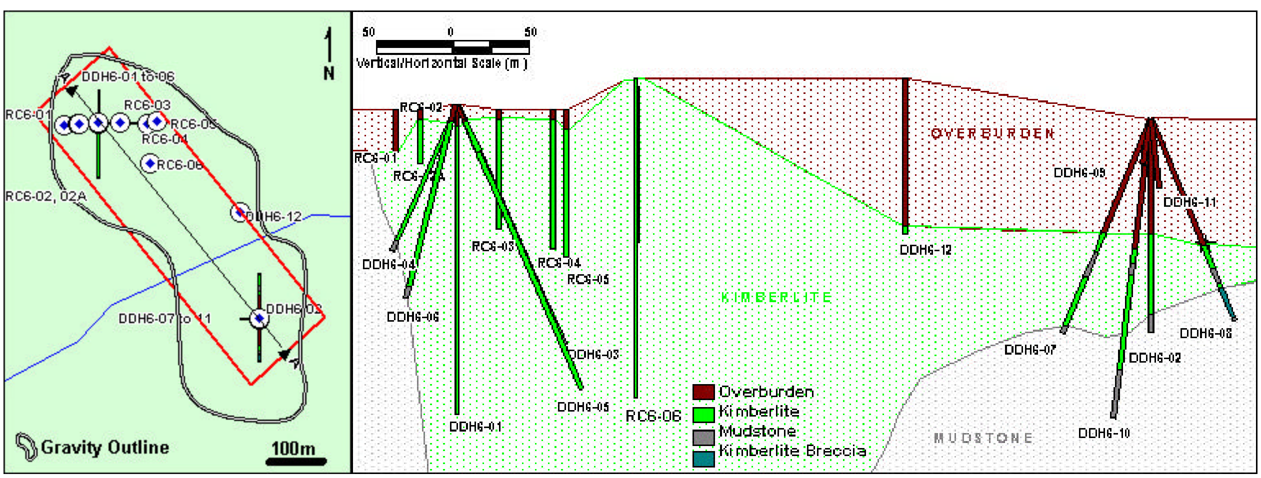

Figure 15 K6 drill hole location plan and composite cross section, looking northeast.

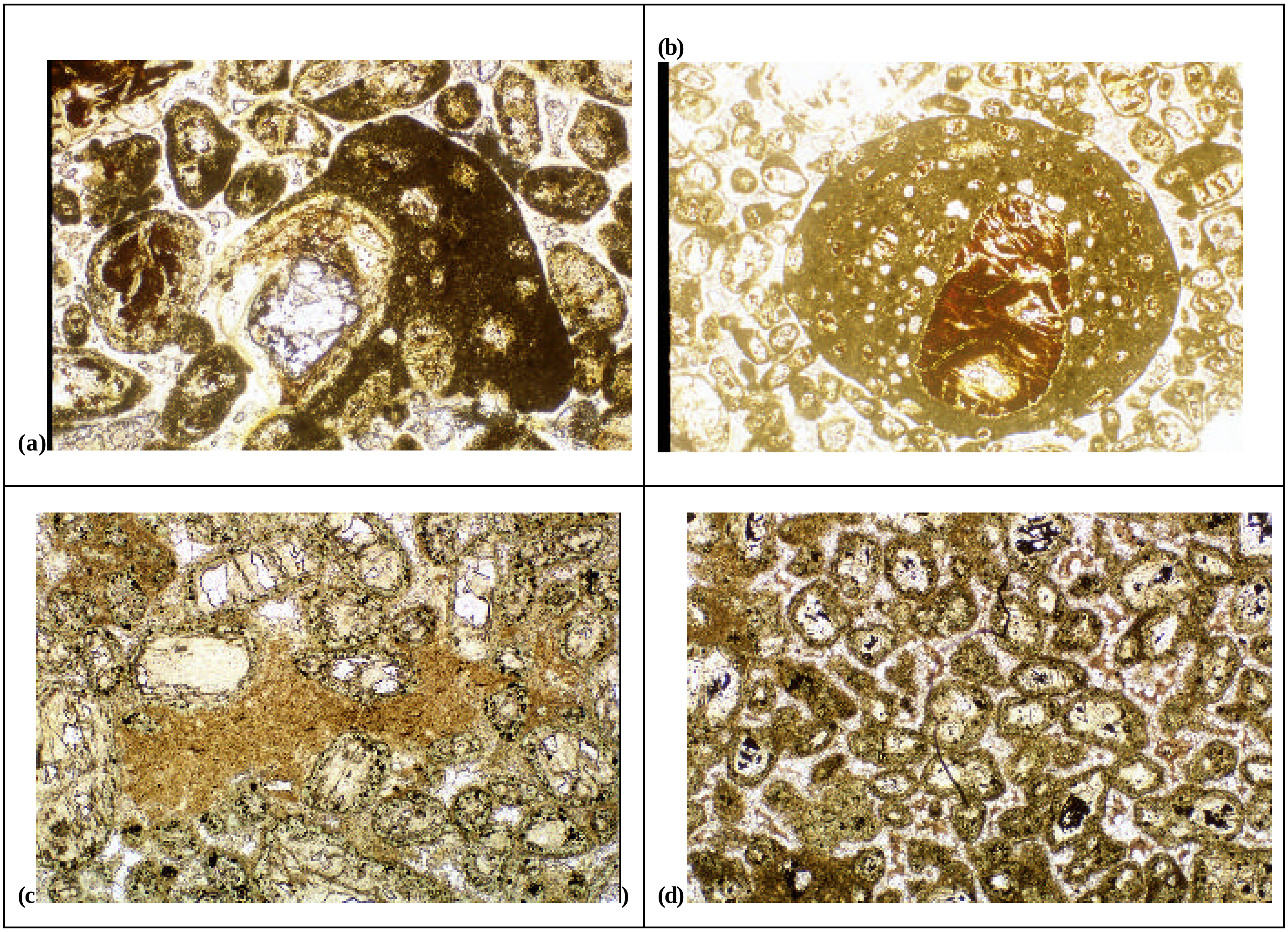

Figure 16 Thin sections from the K6 kimberlite showing various textural features (a) Lapilli-bearing olivine tuff - 35 m. Broken lapilli containing a large (broken) olivine macrocryst and several smaller olivine phenocrysts . Surrounding the central lapilli are other lapilli at least one of which displays a broken selvage. (WOF/FOV=2.5mm) **(b)** Magmaclast bearing olivine tuff –35 m. Juvenile lapilli cored by an olivine macrocryst and containing abundant olivine phenocrysts. The matrix material is composed of a fine grained mix of carbonate and serpentine. (WOF/FOV= 5.1mm) **(c)** Lapilli-bearing olivine tuff with deformed shale xenolith -164.7m. Deformed brown shale xenolith surrounded by kimberlitic material and with individual olivines embayed into the sides. Many of the olivines in this figure show "necklace texture" alteration consisting of a rim of fine serpentine containing a ring of opaques. (WOF/FOV=2.5mm) **(d)** Olivine tuff K6 – 179.1 m. Olivine phenocrysts of a single size present in this sample provide evidence of sorting in this area. Although olivine phenocrysts are the main constituent of this sample other constituents (lapilli, country rock etc.) are present but occur in the same size fraction. (WOF/FOV=2.5mm).

8. Conclusions

Of the 37 kimberlites discovered to date in the Buffalo Head Hills Kimberlite province, at least 20 are diamondiferous. Based on the testing of 22 or more tonnes, estimated diamond contents of over 10 carats per hundred tonnes have been established for three of the kimberlites, K14, K91 and K252. In addition, commercial-size and high quality diamonds have been recovered. Significant infrastructure has been established in the region by the oil and gas industry. Therefore, the economic threshold for diamond mining in Alberta may be lower than in other more remote regions in Canada. The work done by the Alberta Diamond Joint Venture has shown that the Buffalo Head Hills region has the potential to host an economic diamond deposit.

References

AULBACH, S, GRIFFIN, W.L., O'REILLY S.Y., AND MCCANDLESS, T.E., The Lithospheric Mantle Beneath the Buffalo Head Terrane, Alberta (Canada): Xenoliths from the Buffalo Hills Kimberlites: Extended Abstracts, Eighth International Kimberlite Conference, Victoria, Canada.

BOYER, L.P., HOOD, C.T., MCCANDLESS, T.E., SKELTON, D.N. and TOSDAL, R.D., Volcanology of the Buffalo Hills Kimberlites, Alberta, Canada. Extended Abstracts, Eighth International Kimberlite Conference, Victoria, Canada.

BURWASH, R.A., KRUPICKA, J. and WIJBRANS, J. R., 2000. Metamorphic evolution of the Precambrian basement of Alberta: The Canadian Mineralogist, Vol. 38, pp. 423-434

CANT, D. J., 1988. Regional structure and development of the Peace River Arch, Alberta: a Paleozoic failed-rift system: Bulletin of Canadian Petroleum Geology, Vol. 36, No. 3, pp. 284-295.

CARLSON S.M., HILLIER W.D., HOOD C.T., PRYDE R.P. AND SKELTON, D.N., 1999. The Buffalo Hills kimberlites: a newly discovered diamondiferous kimberlite province in north-central Alberta, Canada. Proc. 7th Int. Kimberlite Conf., Volume 1. pp. 109-116.

DAVIES, R.M., GRIFFIN W.L., O'REILLY, S.Y., MCCANDLESS, T.E., 2002. Inclusions in Diamonds from Buffalo Hills, Alberta, Canada: Diamond Growth in a Plume?: Extended Abstracts, Eighth International Kimberlite Conference, Victoria, Canada.

DUFRESNE, M.B., ECCLES, MCKINSTRY, B., SCHMITT, D. R., FENTON, M. M., PAWLOWICZ and EDWARDS, W.A.D., 1996. The Diamond Potential of Alberta: Alberta Geological Survey Bulletin No. 63, 158 p.

ECCLES, D.R., HAYNES, M., CSANYI, W., 2001. Diamond and metallic-mineral potential of the Peerless Lake Map area, North-Central Alberta, Alberta Energy and Utilities Board, Alberta Geological Survey Earth Sciences Report 2000-08.

FENTON, M.M., 1984. Quaternary Stratigraphy of the Canadian Prairies. In: Quaternary Stratigraphy of Canada - A Canadian Contribution to IGCP Project 24, R.J. Fulton (ed.) Geological Survey of Canada, Paper 84-10, pp. 57-68.

FENTON, M.M. and PAWLOWICZ, J.G., 1997. Diamond indicator mineral anomaly from till sample site NAT95-134: Alberta Geological Survey Geo-Note 1997-1, 4 p.

FIPKE, C. E., GURNEY, J. J., AND MOORE, R. O., 1995. Diamond exploration techniques emphasising indicator mineral geochemistry and Canadian examples: Geological Survey of Canada Bulletin 423, 86 p.

GURNEY, J. J., 1984. A correlation between garnets and diamonds in kimberlite, in *Kimmberlie Occurrence and Origin: A Basis for Conceptual Models in Exploration.* Harris, P.G., and Glover, J. E. eds; Geology Department and University Extensions, University of Western Australia, Publication 8, pp. 143-146.

HOOD, C.T., MCCANDLESS, T.E., 2003. Xenocryst mineral variations at the province scale, Buffalo Hills kimberlites, Alberta Canada. Extended Abstracts, Eighth International Kimberlite Conference, Victoria, Canada.

LECKIE D.A., KJARSGAARD B.A., COLLINS, M., DUFRESNE, M.D., ECCLES, D.R., HEAMAN, L.M., PIERCE, J., STASIUK, L., and SWEET, R 1997b. Geology of a Late Cretaceous possible kimberlite at Mountain Lake, Alberta - chemistry, petrology, indicator minerals, aeromagnetic signature, age, stratigraphic position and setting: Geological Survey of Canada Open File Report 3441, 202 p.

MOSSIP G.D., and SHETSEN I. (Editors), 1994. Geological atlas of the Western Canada Sedimentary Basin: Published jointly by the Canadian Society of Petroleum Geologists and the Alberta Research Council, 510 p.

ROSS, G.M., 1990. Deep crust and basement structure of the Peace River Arch region: Constraints on mechanisms of formation: Bulletin of Canadian Petroleum Geology, Vol. 38A, pp. 25-35.

ROSS G.M., PARRISH R.R, VILLENEUVE M.E. and BOWRING S.A., 1991. Geophysics and geochronology of the crystalline basement of the Alberta Basin, western Canada. Canadian Journal of Earth Sciences V28, pp. 512-522.