Kimberlites, Melnoites and Look-alikes in British Columbia, Canada

Pell, Jennifer[1] and Ijewliw, Olga[2]

[1] Dunsmuir Ventures Ltd., Canada, [2] Geological Survey of Canada, Canada

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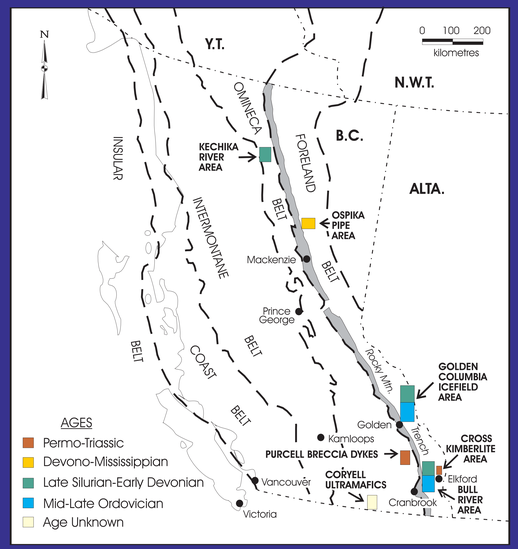
LOCATIONS AND AGES

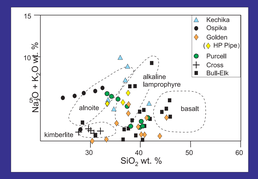
INTRODUCTION

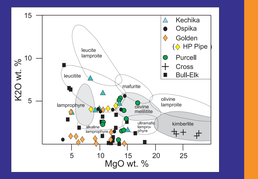
Kimberlites, ultramafic and alkaline lamprophyres and other alkalic ultrabasic rocks occur within a broad belt in the eastern Canadian Cordillera that parallels the Rocky Mountain Trench. Most occur in the Foreland Belt, east of the Trench; however, there are a few documented occurrences in the Omineca Belt, west of the Trench.

All were emplaced into the passive continental margin sedimentary prism prior to the deformation and metamorphism associated with the Jura-Cretaceous Columbian orogeny. They were variably deformed, metamorphosed and transported north-eastwards relative to the mantle and basement which they penetrated. These rocks are part of an alkaline igneous province that also includes carbonatites, nepheline and sodalite syenites and ijolites (Pell, 1994).



DIATREME CHEMISTRY





Not surprisingly, the majority of these alkaline rocks are as hard to classify on the basis of geochemistry as they are petrologically. The age of the rocks, tectonic displacement and metamorphic overprint has probably resulted in some chemical mobility precluding easy classification. The majority of the Bull River suite overlaps the basalt and alkaline lamprophyre fields on an alkali-silica plot; the Golden Pipes scatter with a mean composition near the alkaline lamprophyre field; and the HP and Ospika pipes cluster around the alnoite (ultramafic lamprophyre) field. Only the Cross rocks plot uniquely within a field: the kimberlite field.

ULTRAMAFIC LAMPROPHYRES

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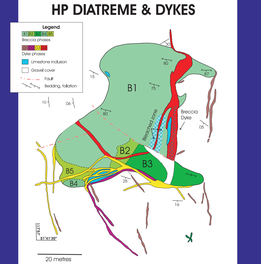
Aillikites, a variety of ultramafic lamprophyre, are found north of Golden (HP Pipe) and north of Mackenzie (Ospika Pipe). The HP Pipe is the southernmost of a series of diatremes in the area north of Golden, the rest of which are better classified as alkaline lamprophyres.

The Ospika Pipe is located approximately 150 metres to the west of the Aley carbonatite complex (Pell, 1994). Radiometric dates on the HP Pipe suggest it was emplaced in the early Devonian, circa 390 to 400 Ma; the Ospika pipe yielded a Mississippian age of 340 to 350 Ma (Pell, 1994).

Both are multiple intrusions containing a number of different breccia phases and dykes hosted by Lower Palezozic carbonate strata. Both have spherical structure (globular segregation) -rich phases and contain autoliths and macrocrysts of mica (biotite or phlogopite), black titaniferous clinopyroxene and chrome diopside in a matrix dominated by carbonate (calcite or dolomite), mica (biotite or phlogopite), chlorite, amphibole, opaque oxides and pyrite +/- talc.

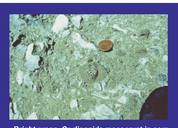
Serpentine is present in the HP Pipe and altered olivine was found in the Ospika Pipe. The HP Pipe also contains melanite (Ti-andradite) garnets in the matrix (Ijewliw, 1991). No mantle xenoliths or diamonds have been recovered from either pipe.

HP Pipe

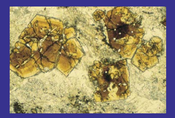


B1-B5 Breccia phases are visually distinctive by relative abundance, type and size of clasts. Clasts are predomoninately marmorized and deformed limestone. Also present areautoliths with megacrystic cores of salite and rarely green chrome diopside as well as crustal or mantle rocks. Megacrysts are clinopyroxene or biotite, phenocrysts are clinopyroxene, biotite, melanite garnet, spinel, pyrite.
D1-D4 dykes phases vary by their outcrop colour and clast contents. D1 are buff brown. The others are dark green. D2 are fine-grained, D3 contain megacrysts. D4 are wholly within the diareme and contain marmorized clasts and megacrysts.

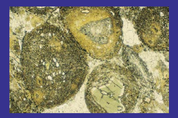
Breccia phase with marmorized clasts transected by dark green, massive 0.5 m dyke



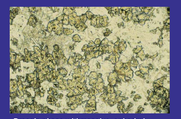
Bright green, Cr-diopside megacryst in core of spherical structure in breccia phase.



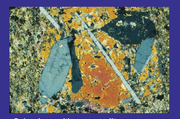
Dyke phase with complexly zoned melanite garnet. Brown bands are Ti-rich. PPL, FOV = 2.8mm



Breccia phase with zoned, green salite and white diopside rim in spherical structure in calcite segregation. PPL, FOV = 2.8mm



Breccia phase withmassive, anhedral, pale Ti-poor melanite garnets. PPL, FOV = 1.2 mm



Dyke phase with orange salite pyroxene, grey euhedral apatite inclusions. XPL, FOV = 2.8mm

Ospika Pipe

Contact between two breccia phases, both with abundant rounded lithic fragments.

ALKALINE LAMPROPHYRES

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Two dozen diatremes and related dykes have been discovered north of Golden. They occur in a 50-km long belt immediately west of the BC-Alberta border and east of the Rocky Mountain Trench. All are hosted in Cambrian or Cambro-Ordovician strata and are deformed and metamorphosed to greenschist facies. A Late Silurian-Early Devonian radiometric date (410 Ma) was obtained from a dyke in the Bush River area (Pell, 1994). Zircons obtained from these intrusions were mostly xenocrystic, yielding Proterozoic and late Archean ages. One euhedral zircon from a dyke at Mons Creek returned a mid- to late-Ordovician age (470 Ma, Parrish and Reichenbach, 1991, Pell, 1994), which possibly represents the age of zircon crystallization and is likely slightly older than the age of emplacement.

A number of different lithologies are present. Rusty to buff to light green weathering breccias consisting of sedimentary rock fragments and sedimentary quartz xenocrysts in a matrix of carbonate, chlorite, iron oxides & talc or serpentine are common to all areas. Those found at Bush River are considerably coarser and more clast rich than in other areas.

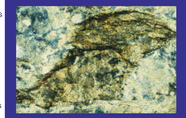
Rusty to dark-green weathered breccias, with altered macrocrysts of mica & olivine in a matrix of carbonate, chlorite, mica (muscovite or biotite), spinel, quartz & apatite +/- altered olivine, serpentine, talc, pyrophyllite, pyrite, altered plagioclase and clay, occur in all areas. Armoured xenoliths, nucleated autoliths and globular segregations or pelletal lapilli occur at Bush River.

Dykes contain macrocrysts or phenocrysts of olivine or olivine pseudomorphs, mica (commonly biotite), pyroxene or pyroxene pseudomorphs +/-amphibole & plagioclase or sanadine in a fine-grained matrix of carbonate, serpentine, biotite (or altered biotite) & opaque oxides, +/- chlorite, clinopyroxene, plagioclase, sphene & quartz.

Mantle xenoliths are rare, some altered spinel peridotites have been found in the Valenciennes River pipes. The Golden Pipes were the target of diamond exploration, predominantly in the late 1980's and pyrope garnet, picro-ilmenite, chromite and a few small diamonds have reportedly been recovered from them.

Metamorphism and alteration makes classifying these rocks difficult. They best fit the alkaline lamprophyre clan (Pell, 1987; Ijewliw, 1992; McCallum, 1994) except for Bush River which resembles olivine kersantite, a calc-alkaline lamprophyre (Ijewliw, 1992).

Valenciennes River



Fiamme like lapilli in buff, sandy breccia phase. XPL, FOV = 1.2mm

Diatreme phase with dark green, altered olivines, larger peridotite xenoliths and black mm-sized spinels.

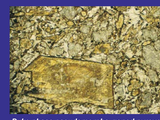
Bush River

Granitic xenolith armoured with magmatic diatreme material forming a spherical structure.

Lens Mountain

Composite images showing a panorama of the Lens Mountain breccia diatreme with phases marked.

Sandy breccia phase with small crustal xenoliths.



Dyke phase pseudomorphs, zoned pyroxenes, olivines, biotites, gray amorphous patches and interstitial calcite. PPL, FOV = 2.8mm

Altered mica megacryst in diatreme phase.

KIMBERLITES

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True kimberlites, five pipes and two dykes, have been identified near Elkford. The Cross diatreme was discovered in the late 1950's but first recognized as a kimberlite in 1976. The Bonus pipe was discovered shortly afterwards and the Ram pipes were discovered in the early 1990's. They intrude Pennsylvanian-Permian carbonate rocks and the Cross Pipe has been dated as late Permian, circa 245 ma (Grieve, 1982; Smith, 1983).

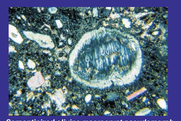
The Cross kimberlite is the best studied of this group (Grieve, 1982; Hall et. al. 1989). It is a multiphase intrusion that contains macrocrysts of phlogopite and serpentinized olivine and xenocrysts of pyrope garnet (G-9 & G-10), chrome diopside, picro-ilmenite, and chromite in a matrix of calcite, serpentine, talc, phlogopite, oxides (rutile, ilmenite and spinel) and apatite. Xenoliths of altered spinel and garnet peridotites, rare fresh garnet lherzolites and glimmerites, and abundant sedimentary rocks are present. Some phases are characterized by spherical structures: peridotite xenoliths coated with kimberlite magma material.

A few small diamonds are reported to have been recovered from the Ram 5 and Ram 6.5 pipes, the largest weighing 0.225 cts.

Cross Kimberlite

Spherical structure, xenolith mantled with kimberlitic magmatic material.

Garnet megacryst with black reaction rim in typically green coloured breccia phase.



Serpentinized olivine macrocryst pseudomorph in kimberlite matrix with smaller altered olivines and relatively fresh phlogopite. XPL, FOV = 1.8 mm.

ULTRA POTASSIC

ULTABASIC-ULTRAPOTASSICS

Two areas west of the Rocky Mountain Trench contain ultra-basic-ultrapotassic rocks. Breccia dykes occur in the northern Purcell Mountains, in southern British Columbia, and a diatreme breccia and related dykes are present in the Kechika River area, northern British Columbia.

The Kechika diatreme and dykes are located in the Cassiar Mountains of northern British Columbia and appear to be part of a suite of alkaline rocks which includes trachytes, syenites, malignites and carbonatites (Pell, 1994).

Based on stratigraphic relationships, they appear to be Silurian or slightly younger and may be part of the late Silurian to Early Devonian emplacement episode. The Kechika diatreme comprises heterolithic breccias containing juvenile and vesiculated glass lapilli, chrome spinel xenocrysts and phlogopite and K-feldspar crystal fragments in a matrix rich in carbonate minerals and potassium feldspars with muscovite and chrome mica. One small diamond was found in the Kechika diatreme.

Kechika Pipe

Breccia phase of pipe with deformed sedimentary xenolith.

ALKALI BASALTS - BULL RIVER CLUSTER

ALKALI BASALTS

Over forty diatremes and related dykes that bear some affinities to limbugites or to the alkali basalt-nephelinite family occur in the Bull River area, east and northeast of Cranbrook. They are hosted in Cambro-Ordovician to Silurian strata and, in some cases, are unconformably overlain either by late Odovician strata (eg. White River diatreme, Helmstaedt et al., 1988 and Mount Dingley Diatreme, Norford and Cecile, 1994) or by basal Devonian rocks (eg. Russell Peak diatreme, Pell, 1987; 1994). No radiometric dates were obtained from these bodies and, therefore, their ages are estimated using stratigraphic relationships.

Most of these intrusions are moderately well foliated and contain altered vesicular glass lapilli, altered olivine & pyroxene crystals with calcite and chrome spinel in a groundmass of carbonate, chlorite, talc & minor plagioclase. They are generally devoid of primary hydrous phases such as mica. In a few areas, unaltered porphyritic rocks containing titanaugite & olivine phenocysts, titanaugite, olivine, labradorite and opaque oxide microphenocrysts in a fine-grained groundmass were observed. Autoliths as well as pyroxenite, peridotite, hornblendite and eclogite xenoliths are sometimes present. No diamonds have been recovered from any of these bodies.

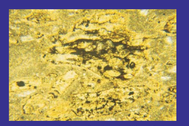
Russell Pipe

Russell Pipe approximately 40 metres across and 200 metres high. Crater comprises diatreme breccia and limestone blocks.
Ob = Basal Devonian unit Otb = Ordovician Beaverfoot Fm
Otp = Ordovician Tipperary Fm
Ls = Limestone rafts Cbx = Coarse contact breccia

Well bedded crater infill material, found near top of pipe, Russell Peak diatreme.

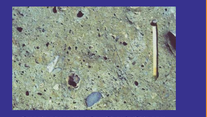
Blackfoot Pipe

The breccia material is the lighter green rock, friable and less resistant than the host sedimentary strata. 200m H x 300m W.



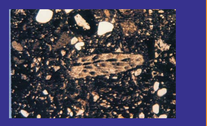
Altered vesicular relic glass lapilli partially compressed probably upon deposition. PPL, FOV = 1.8 mm

Summer Pipe



Breccia phase replete with autolithic and xenolithic rounded fragments.

Quinn Pipe



Breccia phase with fossil fragments (brozoans) and other lithic material. XPL, FOV = 2mm

CONCLUSIONS

An alkaline igneous province in the Canadian Cordillera comprises rocks emplaced into the passive continental margin sedimentary prism prior to the deformation and metamorphism associated with the Jura-Cretaceous Columbian orogeny. Four main periods of emplacement are recorded: mid- to late-Ordovician (~455 Ma - some Cranbrook intrusions, and possibly some dykes in the Golden area); late Silurian to early Devonian (~400 Ma some Cranbrook and Golden pipes and possibly the Kechika diatreme); Early Mississippian (~350 Ma Ospika Pipe); and Permo-Triassic (~245 Ma - Cross Kimberlite and Purcell Dykes). These represent periods of extension or rifting along the western margin of North America.

Although small numbers of diamonds have been recovered from some of these intrusions, the bulk of these bodies do not fit traditional diamond exploration models and many have not been thoroughly explored. Few are true kimberlites or bona fide lamproites. All have been transported and cut off from their roots during orogenesis and therefore have limited volume potential. However, xenocrystic zircons recovered from some of the Golden diatremes indicate that Archean rocks must have underlain the passive margin where they formed, suggesting they were on or near the craton when emplaced.