

**Geological Reconnaissance of Zeolite Deposits  
on the  
Tom and Kitty Claims**

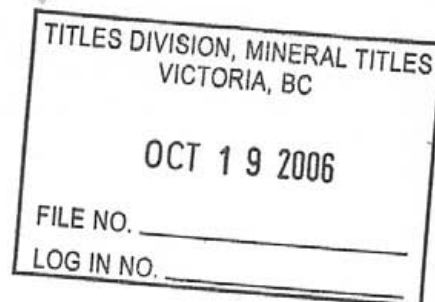
**Manual Creek Area  
Osoyoos Mining Division  
British Columbia**

**Mineral Titles Reference Map M082E022  
Lat. 49°14.6' N, 119°43.9' W**

**-owners/operators-  
B.N. Church and F. Niddery**



**Prepared by  
B. N. Church, P.Eng.  
Victoria, B.C.  
October 15<sup>th</sup>, 2006**



GEOLOGICAL SURVEY BRANCH  
ASSESSMENT REPORT

28576

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## Summary

Zeolite mineralization occurs in abundance at several localities on a 5 km long belt of Eocene dacitic tuff in the Manuel Creek area of southern British Columbia. The tuff is located at mid-section in the Marron Formation in the southern part of the Penticton Tertiary outlier. The zeolitic beds range up to 10 m thick and dips gently easterly. Geochemical results in this study define the major and minor element composition of the zeolitic host rocks, adjacent beds and regional volcanic units. The geochemistry suggests the effective zeolite in these rocks is a calcium-rich variety of clinoptilolite. There is evidence of considerable element mobility between the formations that is best explained by groundwater circulation in the 'open-system' model.

## Introduction

Zeolite minerals are hydrated aluminosilicates of alkaline and alkaline earth elements such as sodium, potassium, magnesium, barium and calcium. They commonly form in nature from the reaction between volcanic ash and alkaline water. The commercial application of zeolite stems from the mineral's capacity for adsorption, catalysis and ion exchange (Griffiths, 1987).

Manufactured 'synthetic' zeolites are also used for ion exchange and molecular sieves in purification of gases and liquids, but at a much higher cost than naturally occurring zeolites. Clinoptilolite and chabazite are two of the most common members of this mineral group used in commercial operations. Generally they may be described as having a cage-like or honeycomb crystal structure. The pores within their structure range in size from 2 to 12 angstroms. The cations within the structure are loosely bound and can be readily exchanged. Therefore these zeolites may be used for ion exchange, chemical sieving, filtering and gas absorption such as to remove odour, toxins and metals from both air and water (Zhao Guangsheng et al., 1988). They are commonly used as human and animal waste adsorbents (Moore, 2000). Also, zeolites have been employed for soil amendments and hydroponics, water filtration in fish farms, enhancement to livestock feed and even storage of solar and waste energy (Breck, 1983, Mumpton, 1999, Chaw, 2002).

In British Columbia zeolite deposits occur most commonly in the relatively young felsic volcanic formations of relatively low metamorphic grade. The typical host rocks are the sediments and pyroclastic units and intercalated lavas that form a northwest-trending belt, about 150 km wide, extending 800 km from the Republic Mining District of Washington state to the Houston area in the central interior of British Columbia. The Most active zeolite properties in this belt are in the Kamloops (Ranchlands MINFILE 092ISE123) and Princeton area (Bromley Vale MINFILE 092HSE166).

## The Property

The property consists of ten (10) two post 'legacy' mineral claims, Kitty 1-7 and Tom 1-3 that are owned, respectively, by B.N. Church of Victoria B.C. and F. Nidderly of Okanagan Falls B.C. Location of these contiguous claims is shown on Figures 2 and 3; other details are as follows:

<b>Claim Name</b>	<b>Tenure No.</b>	<b>Units</b>	<b>Area (Hec.)</b>	<b>Issue Date</b>	<b>Good To</b>
Kitty 1	388945	1	25	Aug. 16 <sup>th</sup> 2001	Sept. 2 <sup>nd</sup> 2011
Kitty 2	388946	1	25	Aug. 16 <sup>th</sup> 2001	Sept. 2 <sup>nd</sup> 2011
Kitty 3	388947	1	25	Aug. 16 <sup>th</sup> 2001	Sept. 2 <sup>nd</sup> 2011
Kitty 4	388948	1	25	Aug. 16 <sup>th</sup> 2001	Sept. 2 <sup>nd</sup> 2011
Kitty 5	388949	1	25	Aug. 16 <sup>th</sup> 2001	Sept. 2 <sup>nd</sup> 2011
Kitty 6	390678	1	25	Nov. 7 <sup>th</sup> 2001	Sept. 2 <sup>nd</sup> 2011
Kitty 7	390679	1	25	Nov. 7 <sup>th</sup> 2001	Sept. 2 <sup>nd</sup> 2011
Tom 1	388950	1	25	Aug. 16 <sup>th</sup> 2001	Sept. 2 <sup>nd</sup> 2011
Tom 2	388951	1	25	Aug. 16 <sup>th</sup> 2001	Sept. 2 <sup>nd</sup> 2011
Tom 3	388952	1	25	Aug. 16 <sup>th</sup> 2001	Sept. 2 <sup>nd</sup> 2011

## Location and Access

The Tom and Kitty claims are located 7 km northeast of the town of Keremeos at the head of Manuel Creek between 1160 and 1360 m elevation. Access to the property is 10 km south of the Twin Lakes turnoff from Highway 3A via the Twin Lakes and Grand Oro roads.

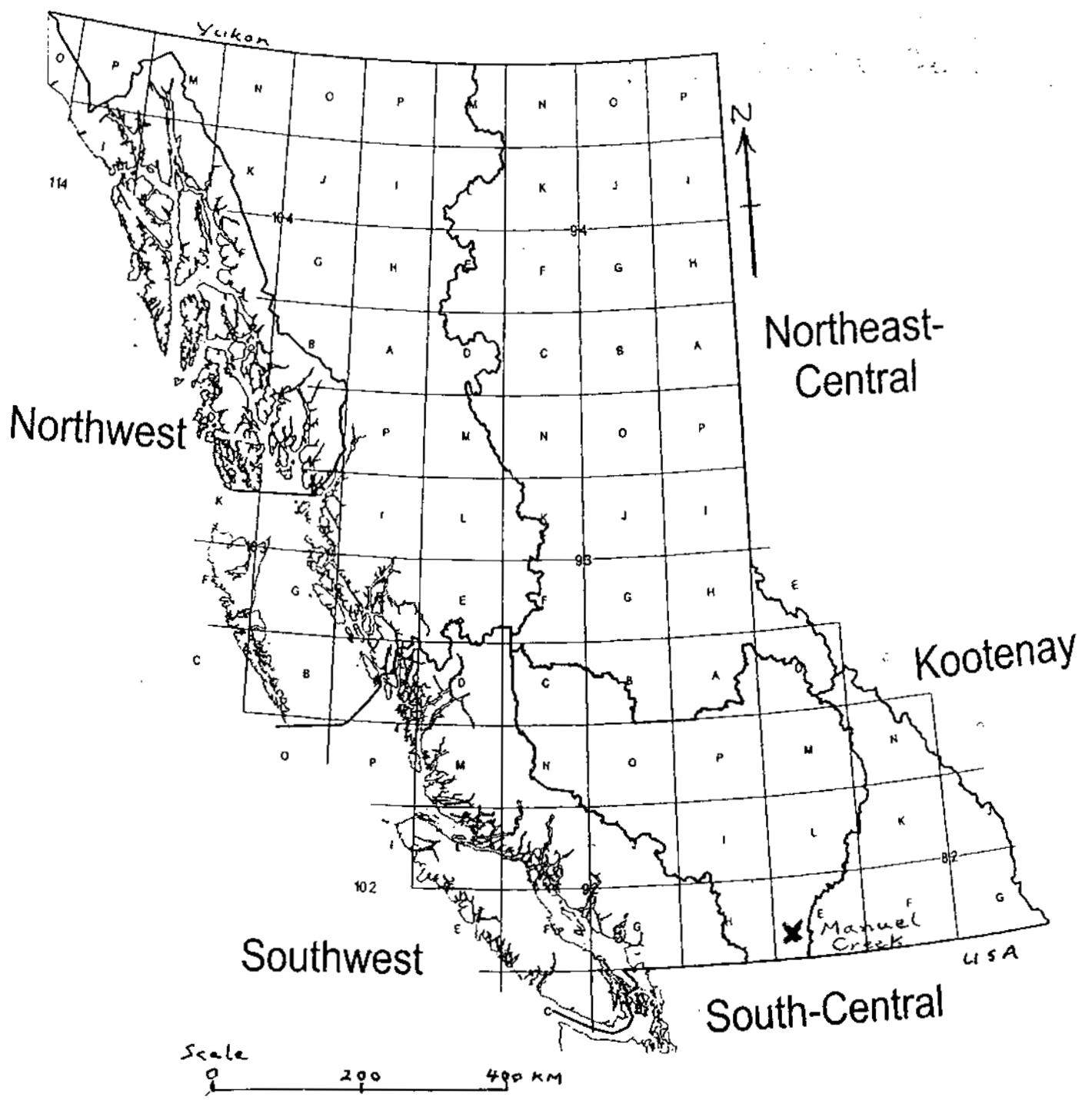
## Physiography and Climate

The region is characterized by subdued mountainous terrain at the southern extremity of the Thompson Plateau. Here the rounded glaciated summits (elev. to 1590 m) are deeply eroded by streams flowing easterly towards Okanagan Lake (elev. 340 m) and southwest to the Similkameen Valley (elev. 550 m).

The low parts of the region and south-facing slopes are generally open grasslands. Summits and north-facing slopes have forests of lodgepole and ponderosa pine that support intermittent logging operations. Rock exposures occur mainly on ridge tops, bluffs, road cuts and some stream banks.

Although the Okanagan Valley is semi-arid, the adjacent Thompson Plateau to the west receives as much as 50 cm of annual precipitation. The headwater area of Manuel Creek is covered by snow accumulations, up to 1 m thick, from November to April.

# Figure 1 Location Map



# Figure 2 Claim Map



MINISTRY OF ENERGY AND MINES

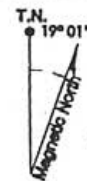
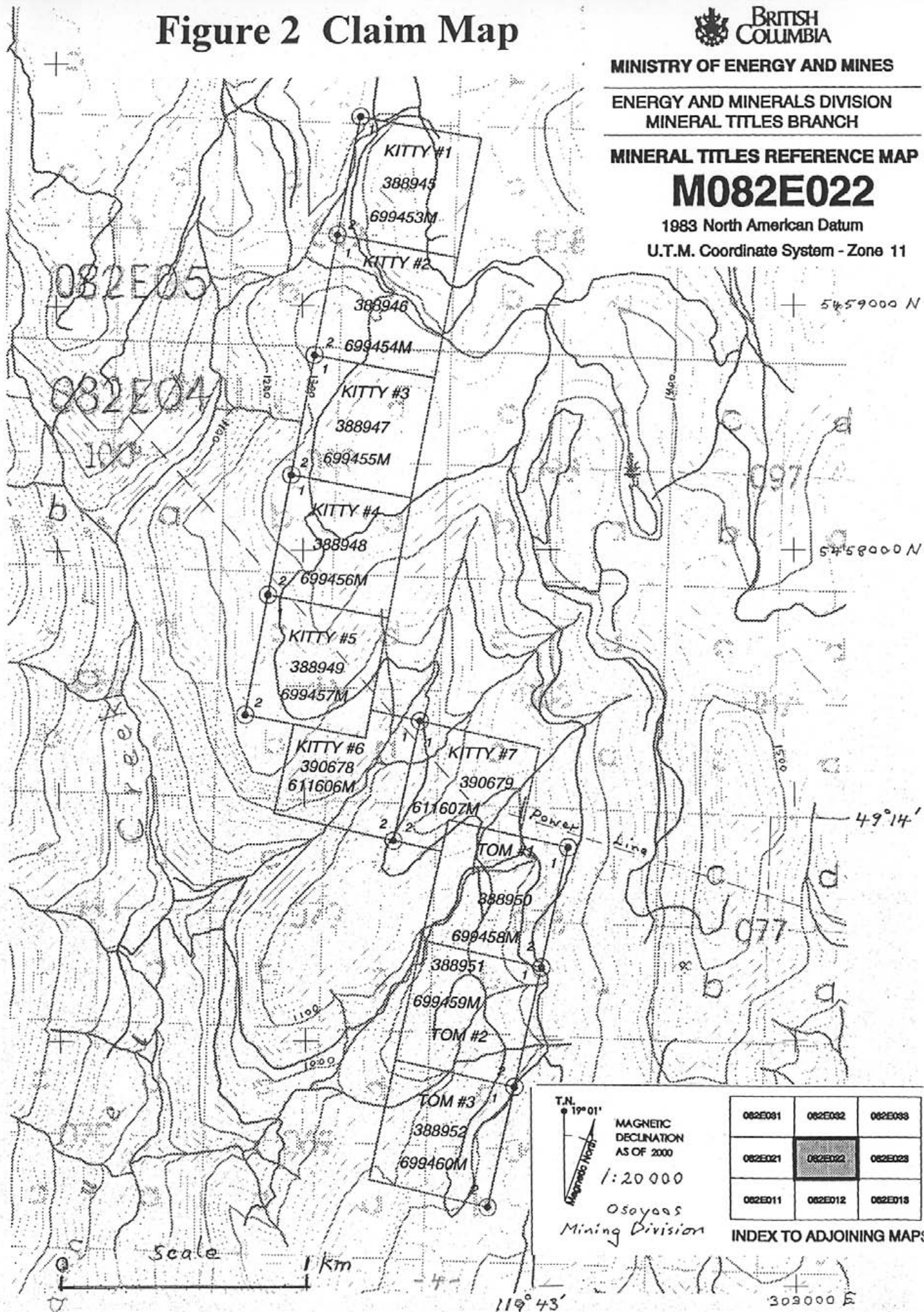
ENERGY AND MINERALS DIVISION  
MINERAL TITLES BRANCH

MINERAL TITLES REFERENCE MAP

## M082E022

1983 North American Datum

U.T.M. Coordinate System - Zone 11



MAGNETIC DECLINATION AS OF 2000

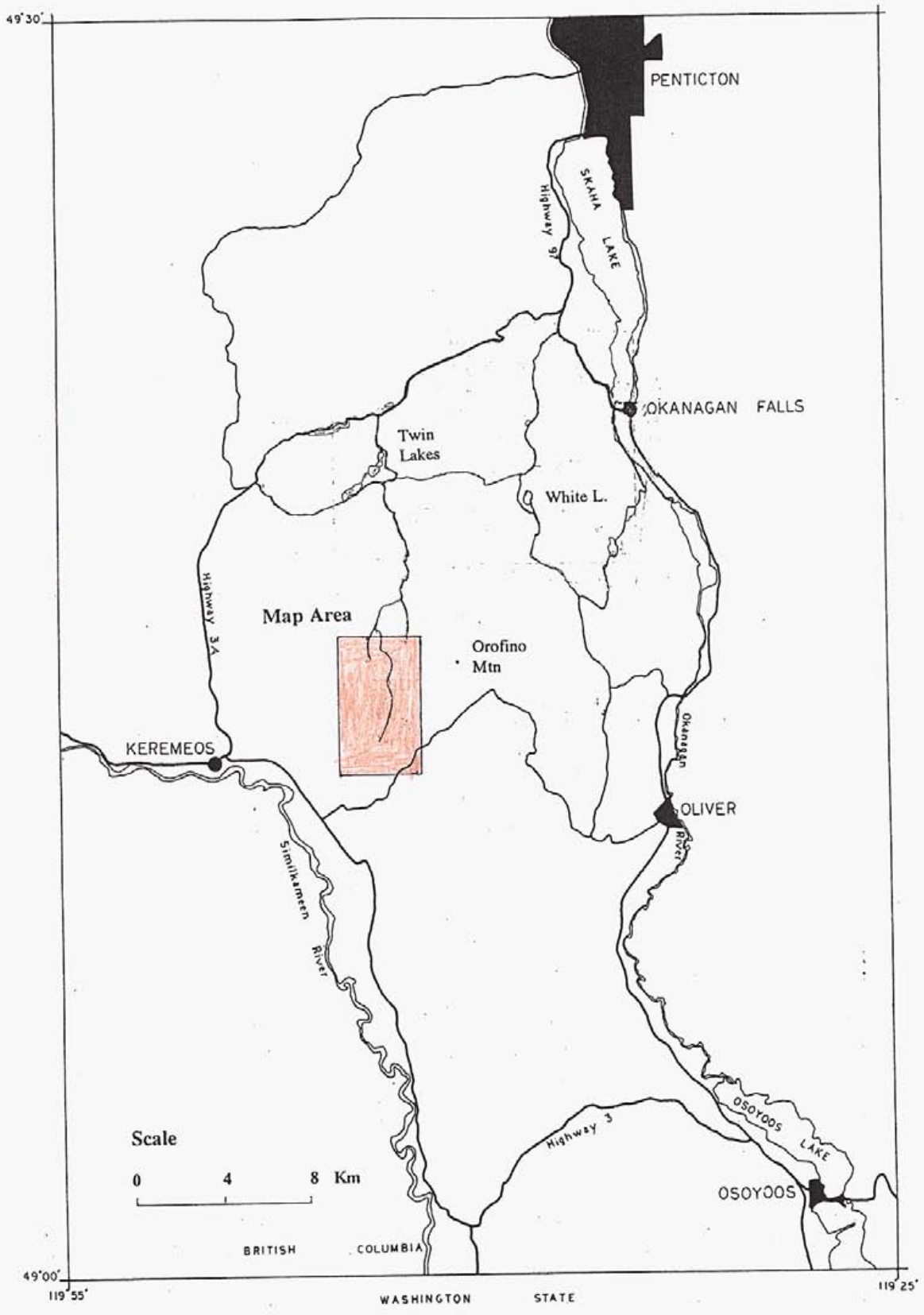
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Osage Mining Division

082E001	082E002	082E003
082E021	082E022	082E023
082E011	082E012	082E013

INDEX TO ADJOINING MAPS

# Figure 3 Access to the Map Area



## History

The word 'zeolite' is derived from the Greek phrase 'boiling stones' in reference to the visible loss of water on heating (Breck, 1983). Devitrified volcanic ash and zeolitic tuff comprised the raw material of pozzolan cement that was first used by the Romans in construction of their highways, aqueducts and public buildings in Italy and throughout Europe. Cronstedt (1756) identified stilbite and first recognized zeolites as a new group of minerals. In 1845 it was discovered that certain zeolitic soils had the facility of retaining ammonium salts. Then the quantitative cation exchange characteristic of chabazite and other zeolite minerals was studied. McBain (1932) applied the term 'molecular sieve' to porous crystalline materials, mostly zeolite minerals that exhibit the property of acting as sieves for gas molecules. It was also recognized that zeolites used as adsorbents do not exhibit any structural change when they are dehydrated under very severe conditions withstanding temperatures of about 700°C. In the laboratory it was also found that zeolites must be dehydrated before use by heating to a temperature of at least 350°C. The pioneering research of R.F. Milton and his associates at Union Carbide Corp., beginning in 1948, resulted in the first synthesis, and later the commercial manufacture, of molecular sieve zeolites. The properties and uses of zeolites are now being explored by many diverse scientific disciplines.

Natural zeolites were first found in the volcanic rocks of the White Lake basin, in the Penticton area of British Columbia (Church, 1973). Then in the mid 1980's zeolites were located in Tertiary sedimentary rocks in cuts on Highway 3 near Princeton (MINFILE 092HSE 165) and nearby in similar rocks at Bromley Vale (MINFILE 092HSE 166) and Sunday Creek (MINFILE 092HSE 168). Subsequently, in the late 1980's, zeolites were found at Ranchlands (MINFILE 092INW 095) in the Cache Creek Tertiary basin. The Ranchlands deposits are centred 4.5 km northeast of Cache Creek, 68 km west of Kamloops, B.C. The 'Z-1' deposit, developed by Highwood Resources Ltd. consists of two seams of zeolitized vitric tuff, each 5 to 8 m thick in an area underlain by volcanic and sedimentary rocks of the (Eocene) Kamloops Group. The production, amounting to about 2,000 tonnes per year, is used mainly as a cattle feed amendment in Alberta. The nearby 'Z-2' deposit owned by Industrial Mineral Processors is a 10 m thick heulandite and clinoptilolite bearing rhyolite tephra within a shale/siltstone lens. Production from this deposit goes through the company's processing and packaging plant in Ashcroft. Near Princeton, progress was made to bring the Bromley Vale zeolite deposit into full production. In 2004 United Zeolite Products Ltd. obtained a five-year contract with Haliburton Energy Services Inc. to deliver a specialty zeolite for use in lightweight cementation for oil and gas wells. At the same time Canmark International Resources Inc. continued work on its Sunday Creek zeolite deposit for the domestic market.

The current investigation of zeolites in the Tertiary rocks of the Penticton area builds on the previous work of Church (1973, 2002) and Hora and Church (1986). This has resulted in the discovery of significant clinoptilolite deposits at several localities on a 5 km long belt of Eocene dacitic tuff (the Manuel Creek tuff) located 7 km NE of Keremeos.



## Geological Setting

Zeolites are commonly best preserved in Cenozoic volcanic rocks because of the low grade of regional metamorphism of these formations (Hora and Church, 1986). Large areas of the interior plateau region of British Columbia are underlain by deeply dissected early Tertiary lava, associated pyroclastic rocks and interbedded sedimentary units of the Penticton and Kamloops Groups. The thickness of these rocks ranges from less than 100 m to more than 1,200 m. The base of the succession where best developed is composed of fluvial sandstone and conglomerate. The upper boundary of these rocks is generally coincident with a gently rolling upland surface that is locally unconformably covered by a veneer of Miocene and younger 'plateau lavas' of the Chilcotin Group.

The Penticton Tertiary outlier, the type area of the (Eocene) Penticton Group, covers approximately 430 km<sup>2</sup> between the towns of Penticton and Okanagan Falls in the Okanagan Valley and the village of Keremeos to the southwest in the Similkameen Valley (Church, 2002 a). The Springbrook Formation, at the base of the group, is a polymictic conglomerate containing clasts derived by stream erosion of geologically diverse Mesozoic and Paleozoic terranes. In the vicinity of Manuel Creek, the Marron Formation overlies the Springbrook. The Marron consists of phonolite, trachyte, andesite and basalt lava flows and breccia deposits about 1,700 m thick. Above this sequence, the Marama Formation comprises an array of dacitic lava domes that are scattered across the region. In the east part of the Penticton outlier, the White Lake Formation (1000 m thick) is a succession of fluvial, lacustrine, lahar and volcanic breccias developed unconformably on the Marron and Marama Formations. Completing the Penticton Group, the Skaha Formation is a mainly chaotic landslide breccia at the top of the Eocene succession.

Structural control of these rocks is a north-south stress scheme related to oblique subduction of the Pacific plate under the North American craton. This stress engine was active intermittently throughout the Cordillera during the Tertiary. The result is a complex inter-relationship of shears, tension faults and folds and simultaneous development of grabens, folding and thrusting. In overall scheme the rocks of the Penticton outlier dip easterly towards major gravity faulting in the Okanagan Valley to form a trap-door-like half graben structure.

The zeolitic beds of the Manuel Creek tuff are exposed a distance of about 5 km in road cuts and cat trenches on the Tom and Kitty claims (Figs. 4 and 5). The tuff occurs between the Kitley Lake member (below) and the Kearns Creek member (above) at mid-section in the Marron Formation (Church, 2002 a). At several localities, such as MAN 28b and MAN 78a, the Manuel Creek tuff is intercalated with other well bedded sedimentary rocks including sandstone (see ECOKA-22, Appendix B) and shale with fossil leaf fragments and other carbonaceous trash. This suggests the tuff was deposited, in part, into an aqueous medium that may have aided the zeolitization process.

The Manuel Creek tuff is a minor unit conformable with the Kitley Lake member (K/Ar biotite  $53.1 \pm 1.8$  Ma). The tuff beds range up to 10 m thick, dip 15 to 30 degrees easterly, and are exposed on a bench (west of the Park Rill fault) formed by the glacial erosion of the overlying Kearns Creek basalt. The tuff is mainly gray or beige, massive and characterized by scattered small black specks of biotite and amphibole. In thin section the rock consists mostly of glassy shards replaced by authigenic zeolite and clay (see MAN-78b, Appendix B). The main minerals are plagioclase, sanidine and quartz. X-ray diffraction and cation exchange capacity (CEC) analyses indicate the presence of zeolite in local abundance (Church, 2002b). Silicate analyses confirm dacitic composition of the tuff which is similar to the average for clinoptilolite ( $\text{SiO}_2$  57.8 – 67.2 %, LOI 1.66 – 13.2 %).

At several localities, such as MAN 28b and MAN 78a, the Manuel Creek tuff is intercalated with other well bedded sedimentary rocks including sandstone (see ECOKA-22, Appendix B) and shale with fossil leaf fragments and other carbonaceous trash. This suggests the tuff was deposited, in part, into an aqueous medium that may have aided the zeolitization process.

The Kitley Lake unit is the thickest (~350 m) and the most widely distributed member of the Marron formation in the Manuel Creek area. These rocks are buff coloured porphyritic trachyte and trachyandesite lavas. Single lava flows are resistant to erosion and form cliffs as much as 30 m high. The dominant phase of this rock contains clots (glomerophenocrysts) of feldspar (3-6 mm in dia.), some smaller pyroxene grains and/or biotite set in a fine-grained, light coloured matrix. Plagioclase is the main feldspar but sanidine is locally abundant occurring as discrete glassy laths or mantles on plagioclase (see CLM-73, Appendix B).

The Kearns Creek member is the middle unit in the Marron formation. It attains a maximum thickness of about 300 m, near the center of eruption, in the central part of the map-area. These rocks are usually dark brown, vesicular basalt lavas and flow breccias. Thin sections show a dense charge of pyroxene phenocrysts with a few interspersed plagioclase laths and some corroded olivine as solitary grains and/or forming a restate core in the pyroxene (see MAN-29, Appendix B). Except for a short section of stout columns extending north from the power line on the Kitty #3 claim, the unit is markedly weathered and severely eroded.

# Figure 4 Geology

## M082E022

1983 North American Datum

U.T.M. Coordinate System - Zone 11

### Legend

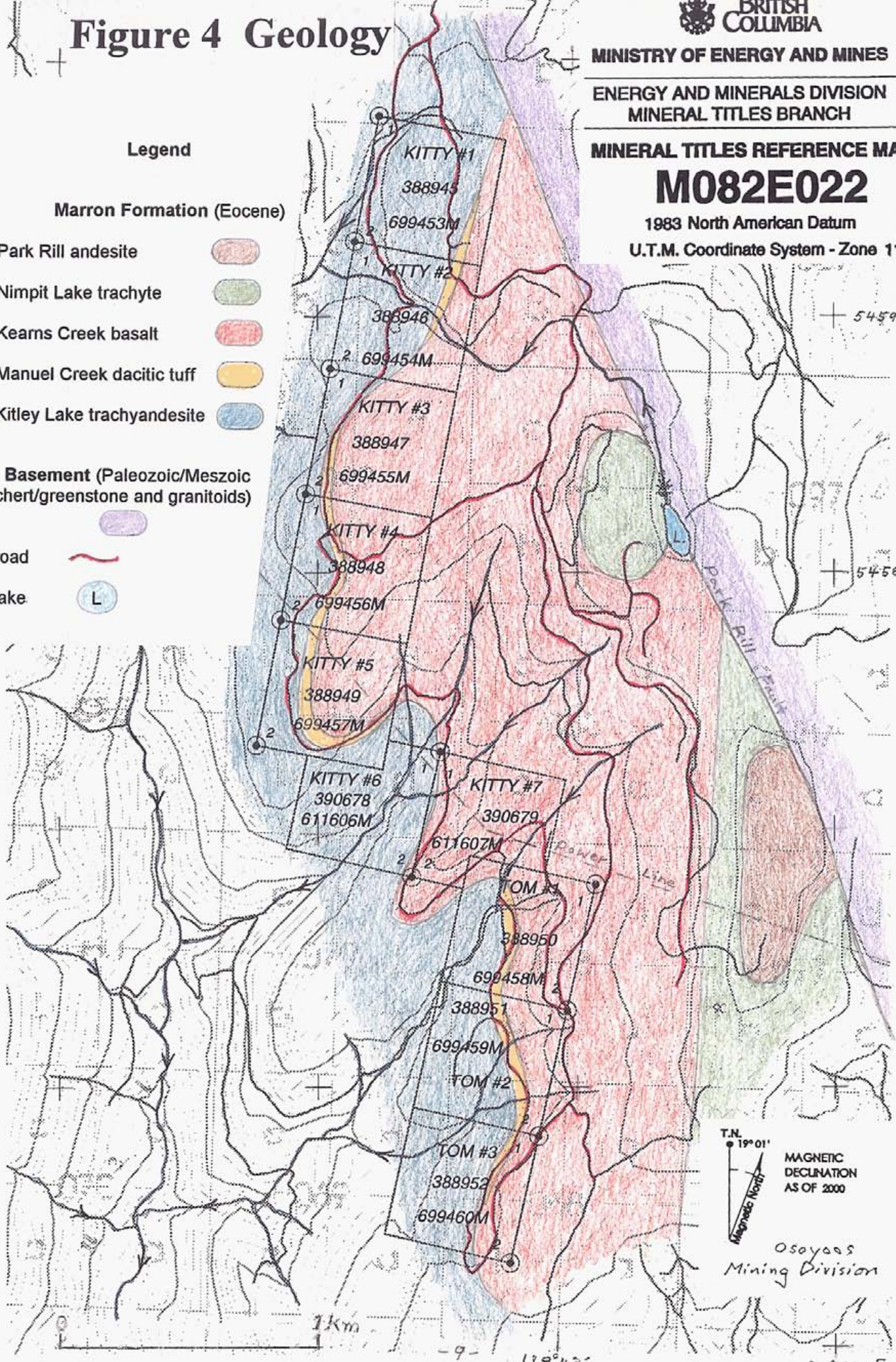
Marron Formation (Eocene)

- Park Rill andesite
- Nimpit Lake trachyte
- Kearns Creek basalt
- Manuel Creek dacitic tuff
- Kitley Lake trachyandesite

Basement (Paleozoic/Mesozoic  
chert/greenstone and granitoids)

road

lake



T.N. 19°01'  
MAGNETIC DECLINATION  
AS OF 2000

Osageas  
Mining Division

## **Program**

### **Objective**

The objective of this program is to locate specific targets for zeolite development based geological mapping, previous property work and new exploration. The main data-base for the area consists of a regional reconnaissance for zeolites by Hora and Church (1986), geological mapping Church (2002), Green (2005) and Assessment Reports 28889 and 27204.

### **Deposit Models**

According to Sheppard (1983) zeolite deposits are readily classified according to geological setting: (1) hydrothermal, (2) burial metamorphism, (3) weathering, (4) open systems, (5) close systems. The most voluminous and potentially valuable zeolite deposits belong to (4) and (5). The terms 'open system' and 'closed system' are used in a hydrological rather than a thermodynamic sense.

The hydrothermal type includes those zeolite occurrences associated with metallic minerals especially hot-spring deposits. Zeolite assemblages of geothermal origin commonly show a temperature zonation such as the successive development of mordenite, laumontite and wairakite that correlates with an increase in temperature.

Zeolites of the burial metamorphic type demonstrate a vertical zonation of mineral assemblages that is characterized by a downward development of clinoptilolite-heulandite-analcime, laumontite-albite and then prehnite-pumpellyite-albite. This vertical sequence is one of increasing temperature/pressure conditions and decreasing hydration with depth; however, chemical variables may be equally important. For example, locally a zone rich in wairakite may overlap with these assemblages. Burial metamorphism generally requires at least 3000 m of overlying strata.

Documentation of zeolites produced by weathering are few, but many deposits have probably been overlooked. An example is Olduvai Gorge of Tanzania where chabazite, natrolite and phillipsite occur in alkaline saline soil profiles. Zeolite abundance appears to decrease with depth. Elsewhere analcime has been detected in soils one metre thick.

Open-systems are deposits formed by the reaction of meteoric water with volcanic glass where the original volcanic rock was deposited on land in a lacustrine or fluvial setting. Commonly the zeolites are the result of hydrolysis and solution of silicic glass and reaction with subsurface water moving into the sediment. The deposits may form in thick tuffaceous strata and show a vertical zonation of authigenic minerals. The upper part of the formation contains unaltered glass and/or clay. In thick sections the zeolitic tuff may continue successively downward through zones rich in clinoptilolite, mordenite and then analcime. These zones often cut across stratigraphic boundaries.

Closed-system deposits form during the diagenesis glassy tuffs in alkaline saline lakes of the with high pH conditions. This probably accounts for the apparent rapid solution of vitric material and precipitation of zeolites. Typically, the vitric component of the tuff is unaltered or partially altered to clay where the tuff is deposited in freshwater near the shore of the lake. The formation of zeolites is favoured where the tuff falls into moderately saline water, and potassium feldspar forms from the tuff in highly saline and alkaline water in the central part of the basin. Thus individual tuff beds show a lateral zonation in a basinward direction of unaltered glass to zeolites and then to potassium feldspar. The main zeolites in this setting are phillipsite, clinoptilolite, erionite and chabazite. In some cases a zone of analcime separates the zone of potassium feldspar from the other zeolites. Zeolites in saline lake deposits are usually only a few centimeters to a few metres thick.

### **Review of the Data-Base**

Zeolites are a family of alkaline and alkaline-earth aluminosilicate minerals remarkable for their continuous and, in part, reversible hydration – dehydration and base-exchange properties. These minerals consist of a three-dimensional framework of Al+Si tetrahedra in which the structures are open and contain large cavities filled with water molecules and loosely bonded cations. The cavities are interconnected by channels in one or several directions depending on the type of zeolite. Electrical neutrality is maintained within the network of cavities by a balanced mixture of monovalent and divalent cations such as calcium ( $\text{Ca}^{++}$ ), sodium ( $\text{Na}^{+}$ ), potassium ( $\text{K}^{+}$ ), magnesium ( $\text{Mg}^{++}$ ) and barium ( $\text{Ba}^{++}$ ) or other alkaline and alkaline earth elements. These cations can be removed or exchanged without affecting the mineral structure. Also, when the water is removed by heating, the mineral structural framework remains intact and the zeolite becomes a microporous solid.

Among the common zeolites, the development of clinoptilolite and mordenite, with typical high Si/Al compositional ratios, is favoured in siliceous tuffs.

The discovery of clinoptilolite at several localities on a 5 km belt of Eocene tuff near Manuel Creek is the main result of several previous investigations (Hora and Church, 1982; Church, 2002b and Assessment Report No. 27204). The tuffaceous beds, up to 10 m thick, occur at mid-section in the Marron Formation, between the Kitley Lake trachyte lava (below) and the Kearns Creek basalt lava (above) in the southern part of the Penticton Tertiary outlier. Cation exchange capacity (CEC – meq/100g) determinations of the zeolitic beds at four sites in the belt range from 100 to 151.8. Silicate analyses of the tuff (sample Man-78b) indicates a dacitic composition:  $\text{SiO}_2$  57.79 %,  $\text{TiO}_2$  0.49 %,  $\text{Al}_2\text{O}_3$  14.26 %,  $\text{Fe}_2\text{O}_3$  3.32 %,  $\text{MnO}$  0.02 %,  $\text{MgO}$  2.33 %,  $\text{CaO}$  4.84 %,  $\text{Na}_2\text{O}$  1.05 %,  $\text{K}_2\text{O}$  1.01 %, LIO 13.17 %.

The most likely origin of clinoptilolite is an ‘open system’ whereby the glassy component of the tuff reacted with alkaline ground water migrating from the adjacent volcanic pile. The accompanying sandstones and shale facies are intermittent and tend to be zeolite-poor unlike ‘closed system’ deposits.

## **Current Project**

A geological/geochemical investigation of the Tom and Kitty legacy claims was completed in the period July 16 to 23, 2005. This followed a reconnaissance survey of the same area in 2002 that indicated significant clinoptilolite at four sites in the Manuel Creek tuff (Assessment Report No. 26889). Altogether 34 rock samples were collected processed for this program. The object was (1) to establish the petrographic and geochemical characteristics of the zeolitic and non-zeolitic rocks to facilitate future exploration and (2) to test the 'open-system' hypothesis of zeolitization. The rock collection consists of 14 samples of Manuel Creek tuff (Nos. RO1.4169 to -86), five additional tuff samples showing significant zeolitization (Nos. ECOKA-21A, MAN-10B, MAN-36, MAN-76 and MAN-78B), two samples of Kearns Creek basalt (Nos. 18017M and 18023M) and 13 samples of typical Kamloops basalt (Nos. 24983M to -95M) – see Appendix 'C' this study. The samples were described according to location, rock type, mineralogy and origin (Table 1) then they were shipped to SRC Geoanalytical Laboratories in Saskatoon, Saskatchewan. At SRC the samples were analysed for 9 major oxides ( $\text{TiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{Fe}_2\text{O}_3$ ,  $\text{MnO}$ ,  $\text{MgO}$ ,  $\text{CaO}$ ,  $\text{K}_2\text{O}$ ,  $\text{Na}_2\text{O}$ ,  $\text{P}_2\text{O}_5$ ) and 21 minor elements (Ag, Ba, Be, Cd, Ce, Co, Cr, Cu, Dy, Er, Eu, Ga, Gd, Hf, Ho, La, Li, Mo, Nb, Nd, Ni, Pb, Pr, Sc, Sm, Sn, Sr, Ta, Tb, Th, U, V, W, Y, Zr). The analytical method followed the routine whereby the samples were subjected to total dissolution by tri-acid digestion ( $\text{HF}/\text{HNO}_3/\text{HClO}_4$ ), and final determination was done by ICP-mass spec.

The Geoanalytical Laboratories 2006 brochure entitled 'Fee Schedule' (see Appendix C) provides details of the analytical methods. For the 30 element 'ICP Package 4.2' detection limits for the major oxides range from 0.001 to 0.01 % and for the minor elements 0.2 to 1 ppm. The quality of the results is gauged by replicate analyses and the use of standard samples. In addition, to facilitate comparing the results for the Marron volcanic rocks, 13 samples of Kamloops Gp. basalt were also analyzed (see Geological Fieldwork 1982, pages 101-104).

## **Geochemical Results**

The composition of Manuel Creek tuff, based on silicate analyses of sample MAN-78b, is clearly dacitic but characterized by unusual low alkalis ( $\text{Na}_2\text{O}+\text{K}_2\text{O}$ ) similar to the other zeolitized tuff samples ECOKA-21a, MAN-10b, MAN-36 and MAN-76 (this study, Appendix C). The low alkalis is explained by the high vitric shard content of this rock (see MAN-78b, Appendix D). This 'glassy' tuff is believed to represent a pyroclastic facies deposited remote from the source volcano. A much denser crystal laden facies of the tuff, rich in alkali feldspar (sanidine) and biotite, settled-out from the dust cloud near the eruption center.

Silicic tuffs favour the development of clinoptilolite over other zeolites such as chabazite or phillipsite that are more commonly associated with intermediate and mafic volcanic rocks. In quantitative terms, the molecular ratio  $Si/Al > 3.0$  favours the occurrence of clinoptilolite. This ratio for the Manuel Creek tuff is 3.4 (sample MAN-78a). Thus the chemical data tends to support the previous X-ray diffraction identification of significant clinoptilolite in the tuff (Assessment Report No. 26889).

The results of analyses for 30 elements in 35 volcanic rocks, consisting of 20 samples of Manuel Creek dacitic tuff and 15 Eocene basalts are listed (two lists) in Appendix C of this report. The most obvious differences comparing the range of major oxide values are the levels of CaO for the dacitic tuff 3.04 – 5.56 % vs. the basalt 6.02 – 8.26 %; MgO for the dacitic tuff 1.35 – 4.07 % vs. the basalt 4.47 – 14.4 %;  $Fe_2O_3$  for the dacitic tuff 2.86 – 7.29 % vs. the basalt 7.08 – 10.3 %. Surprisingly there is considerably more overlap between the rock types comparing other major oxides, such as  $Na_2O$  and the  $K_2O$  levels, and the concentration range for many of the minor elements including Ba and Sr. This suggests that element mobility might be a factor whereby ground water in an open system might move the alkalis, calcium, iron and other related elements from the Kearns Creek basalt into the underlying Manuel Creek tuff.

Comparing the Kearns Creek basalt (nos. 18017M and 18023M) with the Kamloops basalt (nos. 24983M – 24995M) there are considerable chemical differences. For example the Kearns Creek basalt is enriched in Ba (2220 – 2380 ppm) versus the Kamloops basalt, Ba (910 – 1600 ppm). Among the major oxides the range of  $K_2O$  in the Kearns Creek basalt is at a high level, 5.68 – 6.15 % vs. the Kamloops basalt, 2.28 – 4.45 %; and for  $P_2O_5$  in the Kearns Creek basalt, 0.766 – 0.819 % vs. the Kamloops basalt, 0.497 – 0.631 %. The occurrence of apatite phenocrysts and abundant alkali feldspar (fine grained matrix) in the Kearns Creek basalt probably explains the high  $P_2O_5$ , Ba and  $K_2O$  in these rocks (see MAN-29, Appendix B). Also, the Kearns Creek basalt has a relative abundance of rare earth elements including Gd and the lanthanides La, Ce, Pr, Nd, Sm and Eu. These elements tend to be incorporated in other minerals that are not independent rare-earth minerals but contain these elements as non-essential constituents. Apatite is the only common and quantitatively important mineral among the early crystallites of basic igneous rocks rich in the lanthanides and rare earths (Rankama and Sahama, 1955). It is concluded that the Kearns Creek basalt is a good potential source for numerous elements available to circulating meteoric ground water in the middle and lower part of the Marron Formation.

The current method for the determination of zeolitic rocks is the combination of X-ray diffraction measurements and whole rock silicate analyses by ICP/MS. However, these procedures are insufficient for ore grade evaluation. Consequently CEC analyses remain the method of choice by industry for ore body delineation.

The best result from testing the Manuel Creek tuff is Sample MAN-78b, from the Tom 1 claim, that contains significant amounts of clinoptilolite according to X-ray diffraction analyses. This result is supported by a relatively high CEC value of 151.8 meq/100g). Petrographic examination shows that this rock consists of about 75% zeolitized vitric material (glassy shards), a minor amount of broken feldspar and quartz, plus accessory altered amphibole and biotite (see Appendix B). Chemical analyses indicates combined  $\text{CaO} + \text{MgO} + \text{Fe}_2\text{O}_3 = 6.55\%$  that is normal for dacite, although the sum of alkalis  $\text{K}_2\text{O} + \text{Na}_2\text{O} = 2.27\%$  is low and the alkali earth elements Ba (2320 ppm) and Sr (9310 ppm) are unusually high (see Appendix C). This sample is petrographically and chemically similar to MAN-76, from Tom 3, that has a CEC rating of 128.6 meq/100g. Samples ECOKA-21a and MAN-10b, both from Kitty 3, with CEC ratings of 112.5 and 116.1 meq/100g, respectively, are also chemically similar having  $\text{Al}_2\text{O}_3$  levels at 14.3 and 14.0 %, respectively, and  $\text{CaO} = 4.27$  and  $4.07\%$ , and  $\text{K}_2\text{O} = 2.43$  and  $2.35\%$  etc. Sample MAN-36, from Kitty 5, has a CEC rating of 100 meq/100g. This rock has low amounts of  $\text{Fe}_2\text{O}_3 = 2.97\%$ ,  $\text{K}_2\text{O} = 2.00\%$  and  $\text{P}_2\text{O}_5 = 0.11\%$  and a general paucity of rare earth elements including La, Ce, Nd, Pr, Sm, Eu, Y, Gd, Dy, Er, Yb and Th.

The Manuel Creek tuff shows good correlation between the abundance of clinoptilolite and high CEC values. Samples such as MAN-60b with abundant Wairakite and no clinoptilolite have relatively low CEC ratings (33.9 meq/100g). Also, there is some suggestion that the adsorption capacity of the tuff is lowered by the presence of iron and other 'cationic poisons' (probably derived from the overlying Kearns Creek basalt via meteoric waters). Examples are MAN-60b with 7.13%  $\text{Fe}_2\text{O}_3$  and samples RO1:4177, -82, -83 and -86 with  $\text{Fe}_2\text{O}_3$  in the 6.36% to 7.29% range.

## Conclusions and Recommendations

The geochemistry shows that the effective zeolite in the Manuel Creek dacitic tuff is a calcium-rich variety of clinoptilolite. No other zeolites were found to be present except the local occurrence of wairakite, the calcium analogue of analcime.

The 'open-system' model for the origin of zeolite is supported by evidence of significant element mobility between the formations. The Kearns Creek basalt is the likely source of calcium, the alkalis and the alkali-earth elements in the circulating ground water. The presence of iron and high levels of other cationic poisons derived from the basalt impairs the adsorptive capacity of the Manuel Creek tuff.

Four sites have been identified for further zeolite exploration on the 5 km long belt of Manuel Creek tuff on the Tom and Kitty claims. These are on Kitty 3 (samples ECOKA-21 and MAN-10), Kitty 5 (sample MAN-36), Tom 1 (sample MAN-78b) and Tom 3 (sample MAN-76).

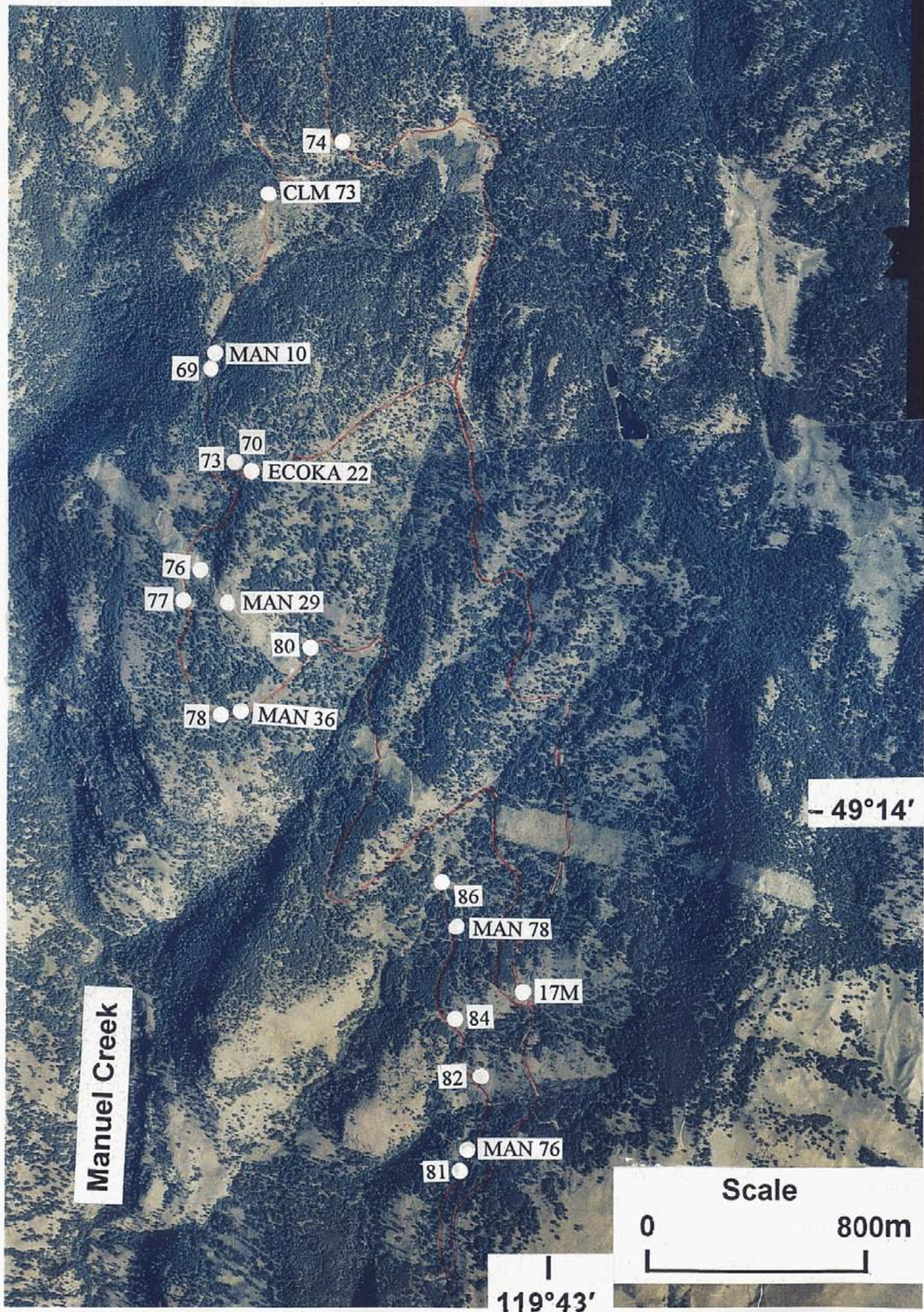
Additional CEC work is necessary to establish the lateral continuity, thickness and grade of potential zeolite ore bodies at the main localities. This program is best achieved by drilling and/or trenching.



**Table 1 Description of Samples (Marron Formation)**

<b>Station</b>	<b>Unit</b>	<b>Mineralogy</b>
ECOKA-21a	Manuel Cr. tuff	clinoptilolite, quartz, plagioclase, amphibole.....
MAN-10b	“ “	clinoptilolite, quartz, plagioclase, clay.....
MAN-36	“ “	quartz, plagioclase, clinoptilolite.....
MAN-60b	“ “	wairakite, sanidine, plagioclase, clay.....
MAN-76	“ “	clinoptilolite, plagioclase, quartz, clay.....
MAN-78b	“ “	clinoptilolite, plagioclase.....
RO1:4169	“ “	clinoptilolite, quartz, plagioclase.....
“ 70	“ “	quartz, plagioclase, amphibole, mica.....
“ 71	“ “	quartz, plagioclase, amphibole, mica.....
“ 73	“ “	quartz, plagioclase, mica, clay.....
“ 74	“ “	sanidine, plagioclase, clay, mica, wairakite.....
“ 75	“ “	plagioclase, sanidine, clinoptilolite, clay.....
“ 76	“ “	quartz, plagioclase, clinoptilolite, amphibole.....
“ 77	“ “	wairakite, orthoclase, clay.....
“ 78	“ “	quartz, plagioclase, clinoptilolite, amphibole.....
“ 80	“ “	sanidine, clay, quartz, clinoptilolite, clay.....
“ 81	“ “	quartz, plagioclase, sanidine, clinoptilolite.....
“ 82	“ “	wairakite, plagioclase, sanidine, clay, quartz.....
“ 83	“ “	quartz, sanidine, plagioclase, clay.....
“ 86	“ “	sanidine, plagioclase, clay, quartz, clinoptilolite.....
18017 M	Kearns Cr. basalt	clinopyroxene, plagioclase, olivine, magnetite, apatite..
18023 M	“ “	clinopyroxene, olivine, plagioclase, magnetite, apatite..

Figure 5 Sampling Stations



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## Appendix A

### Statement of Costs

Labour: geological engineer, Neil Church, P.Eng. July 16-23 <sup>rd</sup> , 2005; 6 days @ \$500/day =	\$ 3,000
Accommodation: (5 night, 1 person)	\$ 325
Meals: (1 persons, 6 days) 6 x \$40	\$ 240
Equipment Rental: GPS unit 5 days @ \$12/day	\$ 60
Vehicle costs: 6 x 100/day	\$ 600
Fuel:	\$ 300
Ferry costs: vehicle & passenger (\$ 47.25 + \$47.25)	\$ 95
TRIM topographic maps (2 x \$5.50)	\$ 11
Analyses:	\$ 1,069
Copying:	\$ 100
Report:	<u>\$ 2,000</u>
<b>Total</b>	<b>\$ 7,800</b>



Saskatchewan  
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17136

June 07, 2006

INVOICE # 137408

CHURCH, NEIL  
600 Parkridge St.  
VICTORIA, BC V8Z 6N7

Customer PO  
Contract #  
Reference

**COPY**

Page: 1 of 1

Attention:

DESCRIPTION	Qty	Price	Amount
06-657, M561 ICP6.3	20.000	27.750	555.00
06-660, M568 ICP6.3	16.000	27.750	444.00
<p>SASKATCHEWAN RESEARCH COUNCIL 15 INNOVATION BLVD SASKATOON SK</p> <p>CARD *****6015 CARD TYPE VISA DATE 2006/07/04 TIME 5181 15:29:04 RECEIPT NUMBER M34410885-001-010-006-0</p> <p>----- PURCHASE TOTAL-CAD <b>\$1,068.93</b> -----</p> <p><b>APPROVED</b> AUTH# 075298 01-027 THANK YOU</p> <p>CARDHOLDER COPY</p>			

Sales Total: 999.00  
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10383

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Terms: A/R Net 30

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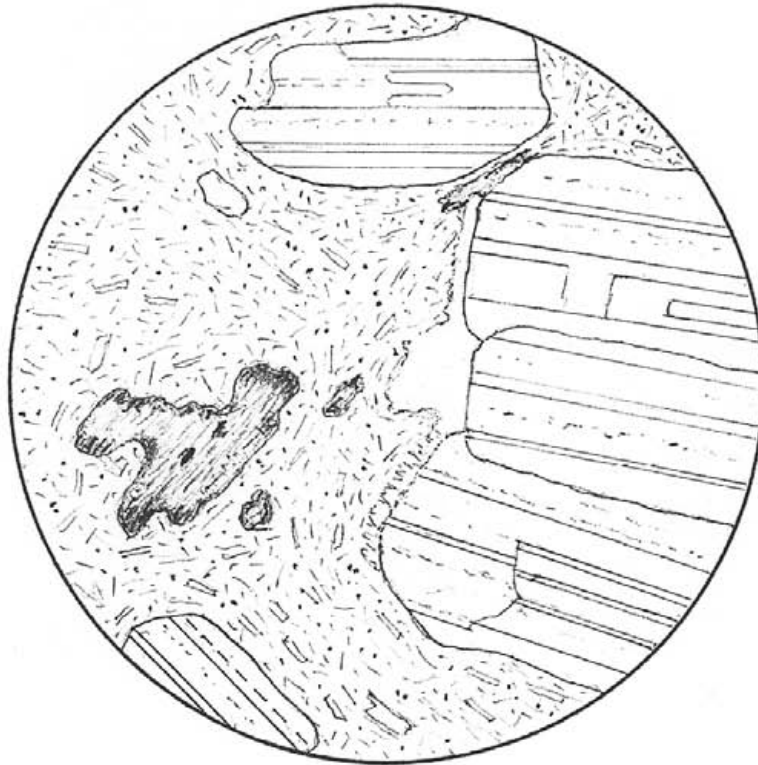
- 19 -

**PAID**

## Appendix B

### Petrographic Descriptions

**Sample CLM-73** Trachyandesite specimen from a bed rock exposure at the bend in the road just south of the small creek crossing near center of the Kitty 2 claim.



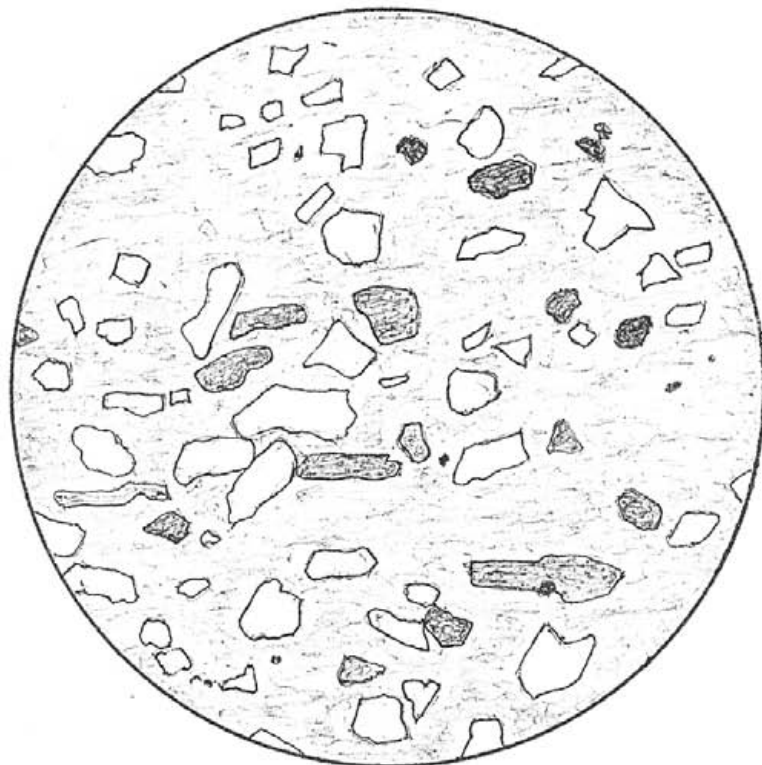
This is a trachyandesite lava flow showing numerous conspicuous plagioclase phenocrysts and corroded biotite set in a groundmass of mostly alkali feldspar microlites and scattered magnetite grains - viewed in plain light (Field Diam. 3.5 mm).

**Sample MAN-29 Basalt specimen from near the base of the high tower on the West Kootenay Power Line in the northern part of the Kitty 5 claim.**



This is a basaltic lava flow with conspicuous augite phenocrysts (some olivine cores) intermixed with zoned plagioclase laths set in a fine grained matrix of similar minerals plus alkali feldspar, apatite and numerous magnetite granules, viewed in plain light (Field Diam. 3.5 mm).

**Sample MAN78b Dacitic tuff** is from a road cut in the south-central part of the Tom 1 claim.



This is a dacite crystal vitric tuff containing numerous small broken crystals of mostly feldspar, some quartz, biotite and amphibole in a matrix of zeolitized glassy shards – viewed in plain light (Field Diam. 3.5 mm).



**Sample ECOKA-22** Volcanic wacke specimen is from fork in the road, northwest part of Kitty 4 claim.



This is an immature volcanic wacke consisting of volcanic rock fragments intermixed with broken feldspar crystals, some quartz, amphibole, biotite and magnetite - viewed in plain light (Field Diam. 3.5 mm).

## **Appendix C**

### **Results (SRC Geoanalytical Laboratories)**



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Web: [www.src.sk.ca](http://www.src.sk.ca)  
Email: [info@src.sk.ca](mailto:info@src.sk.ca)

Geoanalytical Group: 2006-657

## SRC Geoanalytical Laboratories

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June 05, 2006

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Fax: (306) 933-5656

### Neil Church

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Reviewed by:

Chelsey Schneider

*Accreditation: ISO/IEC 17025*

Neil Church  
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PO #/Project:  
Samples: 23

SRC Geoanalytical Laboratories  
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Report No: 06-657  
Date: June 05, 2006

### ICP6.3 Total Digestion

#### Column Header Details

Silver in ppm (Ag)  
Aluminum in wt % (Al<sub>2</sub>O<sub>3</sub>)  
Barium in ppm (Ba)  
Beryllium in ppm (Be)  
Calcium in wt % (CaO)

Cadmium in ppm (Cd)  
Cerium in ppm (Ce)  
Cobalt in ppm (Co)  
Chromium in ppm (Cr)  
Copper in ppm (Cu)

26  
Dysprosium in ppm (Dy)  
Erbium in ppm (Er)  
Europium in ppm (Eu)  
Iron in wt % (Fe<sub>2</sub>O<sub>3</sub>)  
Gallium in ppm (Ga)

Gadolinium in ppm (Gd)  
Hafnium in ppm (Hf)  
Holmium in ppm (Ho)  
Potassium in wt % (K<sub>2</sub>O)  
Lanthanum in ppm (La)

Lithium in ppm (Li)  
Magnesium in wt % (MgO)  
Manganese in wt % (MnO)  
Molybdenum in ppm (Mo)  
Sodium in wt % (Na<sub>2</sub>O)

Niobium in ppm (Nb)  
Neodymium in ppm (Nd)  
Nickel in ppm (Ni)  
Phosphorus in wt % (P<sub>2</sub>O<sub>5</sub>)  
Lead in ppm (Pb)

Praseodymium in ppm (Pr)  
Scandium in ppm (Sc)  
Samarium in ppm (Sm)  
Tin in ppm (Sn)  
Strontium in ppm (Sr)

Tantalum in ppm (Ta)  
Terbium in ppm (Tb)  
Thorium in ppm (Th)  
Titanium in wt % (TiO<sub>2</sub>)  
Uranium in ppm (U, ICP)

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**Neil Church**

Attention:

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Samples: 23

**ICP6.3 Total Digestion**

Column Header Details

Vanadium in ppm (V)

Tungsten in ppm (W)

Yttrium in ppm (Y)

Ytterbium in ppm (Yb)

Zinc in ppm (Zn)

Zirconium in ppm (Zr)

- 27 -

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Samples: 23

**ICP6.3 Total Digestion**

Sample Number	Ag ppm	Al2O3 wt %	Ba ppm	Be ppm	CaO wt %	Cd ppm	Ce ppm	Co ppm	Cr ppm	Cu ppm	Dy ppm	Er ppm	Eu ppm	Fe2O3 wt %	Ga ppm	Gd ppm	Hf ppm
CG515	<0.2	17.7	2230	1.9	4.71	0.7	164	17	122	3	3.6	2.6	2.5	7.42	22	5.1	4.8
R01:4169	<0.2	14.6	1940	1.7	4.11	0.7	63	3	54	7	2.1	1.4	1.0	3.54	19	2.5	3.5
R01:4170	<0.2	15.0	922	1.6	3.07	0.7	48	5	118	5	1.8	1.2	1.1	3.33	22	2.3	2.2
R01:4171	<0.2	15.0	916	1.7	2.98	0.8	50	6	108	6	1.9	1.3	1.1	3.61	20	2.4	2.3
R01:4173	<0.2	15.0	931	1.9	2.96	0.8	51	5	108	8	1.9	1.3	1.1	3.45	21	2.5	2.1
R01:4174	<0.2	17.4	2330	3.7	3.31	0.8	124	11	119	35	3.7	2.5	2.1	5.45	18	5.1	7.0
R01:4175	<0.2	17.3	2000	3.2	4.60	0.8	72	12	123	22	2.6	1.9	1.5	5.37	22	3.3	4.7
R01:4176	<0.2	15.2	1080	1.5	4.42	0.8	22	7	113	14	1.5	1.2	0.8	4.13	20	1.4	2.2
R01:4177	0.2	16.4	1450	2.8	3.47	0.9	113	25	143	60	3.6	2.6	2.2	7.09	16	4.9	5.3
R01:4178	<0.2	14.6	918	1.2	3.58	0.6	24	7	103	14	1.3	1.0	0.7	3.06	18	1.2	2.0
R01:4180	<0.2	16.9	1810	2.9	4.02	0.7	125	7	94	30	4.1	2.7	2.2	5.23	20	5.3	7.3
R01:4181	<0.2	13.5	1630	2.8	3.04	0.6	49	10	82	9	1.8	1.2	0.9	2.96	22	2.0	3.1
R01:4182	<0.2	16.3	1320	1.7	4.86	0.7	89	15	137	21	3.1	2.5	1.9	7.29	18	3.8	5.4
R01:4183	<0.2	15.6	1680	2.7	4.49	0.8	98	10	129	14	3.0	2.3	1.7	6.36	21	3.6	6.0
R01:4186	<0.2	15.5	1690	2.8	5.56	0.8	117	18	241	29	3.6	2.7	2.0	6.59	20	5.0	7.1
ECOKA-21A	<0.2	14.3	1950	1.8	4.27	0.8	62	5	70	9	2.1	1.5	1.0	3.58	18	2.4	3.5
MAN-10B	<0.2	14.0	2450	1.8	4.07	0.7	59	4	45	6	1.9	1.3	0.9	2.99	16	2.3	2.9
MAN-36	<0.2	15.9	1070	1.6	4.90	0.9	19	6	77	12	1.2	0.9	0.6	2.97	19	1.1	2.2
MAN-60B	<0.2	16.5	1670	2.6	4.85	0.8	126	15	128	40	3.7	2.8	2.2	7.13	18	4.9	6.6
MAN-76	<0.2	14.8	2010	3.4	4.15	0.7	52	6	53	13	2.2	1.3	1.0	2.91	17	2.5	3.1
CG515	<0.2	17.8	2240	1.9	4.71	0.9	158	19	116	3	3.6	2.5	2.5	7.31	21	5.2	4.3
MAN-78B	<0.2	14.9	2320	1.9	4.87	0.7	64	5	53	8	2.2	1.4	1.0	3.49	18	2.6	3.5
MAN-76 R	<0.2	14.7	2000	3.4	4.17	0.8	52	6	51	12	2.2	1.4	1.0	2.86	17	2.6	3.1

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Report No: 06-657  
 Date: June 05, 2006

Neil Church  
 Attention:  
 PO #/Project:  
 Samples: 23

ICP6.3 Total Digestion

Sample Number	Ho ppm	K2O wt %	La ppm	Li ppm	MgO wt %	MnO wt %	Mo ppm	Na2O wt %	Nb ppm	Nd ppm	Ni ppm	P2O5 wt %	Pb ppm	Pr ppm	Sc ppm	Sm ppm	Sn ppm
CG515	1.2	3.22	91	29	2.84	0.075	<1	3.22	7	69	23	0.678	17	17	12	8.6	4
R01:4169	0.6	2.73	34	19	2.38	0.049	<1	1.14	9	28	13	0.247	18	7	5	4.1	<1
R01:4170	0.5	4.35	25	37	1.49	0.041	<1	3.18	6	23	16	0.198	12	5	6	3.6	<1
R01:4171	0.7	4.89	26	34	1.60	0.047	<1	3.00	7	24	18	0.204	13	6	6	3.6	<1
R01:4173	0.5	4.98	27	34	1.58	0.041	<1	2.98	7	24	22	0.214	11	6	6	3.6	<1
R01:4174	1.2	9.93	72	21	3.00	0.087	<1	1.96	49	51	36	0.527	27	13	10	7.2	<1
R01:4175	0.9	6.69	41	10	2.96	0.088	<1	2.37	23	32	34	0.398	16	8	9	4.8	<1
R01:4176	0.5	2.26	12	26	2.02	0.054	<1	2.95	4	13	29	0.158	10	3	7	2.1	<1
R01:4177	1.2	4.17	68	16	4.05	0.095	<1	5.10	47	48	55	0.693	25	12	12	6.9	<1
R01:4178	0.4	2.99	12	30	1.44	0.038	<1	2.84	4	12	17	0.152	8	3	6	2.0	<1
R01:4180	1.2	8.10	74	6	2.07	0.059	<1	1.75	52	51	18	0.569	26	13	12	7.4	<1
R01:4181	0.6	5.89	22	18	1.78	0.037	<1	1.21	13	21	31	0.208	16	5	6	3.1	<1
R01:4182	1.1	4.51	52	24	3.79	0.131	<1	3.63	33	39	27	0.484	18	9	14	6.0	<1
R01:4183	1.0	5.37	57	14	2.85	0.076	1	2.27	39	40	16	0.394	21	9	13	5.8	<1
R01:4186	1.2	5.69	69	10	4.07	0.095	<1	2.16	57	48	51	0.533	24	12	15	7.0	<1
ECOKA-21A	0.7	2.43	33	27	2.57	0.052	<1	1.18	9	27	26	0.247	17	7	5	3.8	<1
MAN-10B	0.5	2.35	31	17	2.04	0.035	<1	0.83	8	25	10	0.205	13	6	4	3.7	<1
MAN-36	0.5	2.00	9	15	1.36	0.038	<1	2.76	3	10	12	0.110	12	2	6	1.5	<1
MAN-60B	1.3	5.00	75	10	3.54	0.115	<1	3.47	47	52	33	0.805	24	13	12	7.3	<1
MAN-76	0.6	2.33	22	7	2.14	0.031	<1	1.28	11	24	17	0.206	18	6	5	3.7	<1
CG515	1.3	3.20	87	29	2.81	0.074	<1	3.24	7	66	25	0.678	17	17	12	8.5	5
MAN-78B	0.7	1.20	32	6	2.50	0.041	<1	1.07	10	28	16	0.253	16	7	5	3.9	<1
MAN-76 R	0.6	2.33	23	7	2.12	0.030	<1	1.29	11	24	16	0.206	18	6	5	3.7	<1

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SRC Geoanalytic Laboratories

125 - 15 Innovation Blvd., Saskatoon, Saskatchewan, S7N 2X8

Tel: (306) 933-8118 Fax: (306) 933-5656 Email: geochem@src.sk.ca

Report No: 06-657

Date: June 05, 2006

Neil Church

Attention:

PO #/Project:

Samples: 23

ICP6.3 Total Digestion

Sample Number	Sr ppm	Ta ppm	Tb ppm	Th ppm	TiO2 wt %	U, ICP ppm	V ppm	W ppm	Y ppm	Yb ppm	Zn ppm	Zr ppm
CG515	1190	1	<0.3	13	1.07	<2	120	1	22	1.9	87	160
R01:4169	3890	<1	<0.3	8	0.555	<2	60	1	14	1.3	73	116
R01:4170	910	<1	<0.3	4	0.502	<2	66	1	11	1.0	69	63
R01:4171	863	<1	<0.3	4	0.531	<2	72	<1	12	1.0	71	75
R01:4173	833	<1	<0.3	4	0.522	<2	71	<1	12	1.0	73	77
R01:4174	605	3	0.4	18	0.981	9	128	<1	24	2.3	92	311
R01:4175	2630	1	<0.3	9	0.855	5	105	<1	18	1.7	94	161
R01:4176	2190	<1	<0.3	3	0.569	5	79	<1	11	0.9	81	61
R01:4177	304	3	<0.3	11	1.08	10	145	<1	23	2.3	99	213
R01:4178	1550	<1	<0.3	3	0.496	2	62	<1	9	0.8	67	65
R01:4180	1840	1	0.6	19	1.01	7	122	<1	26	2.5	87	316
R01:4181	3530	<1	<0.3	8	0.511	5	58	<1	10	1.1	67	112
R01:4182	600	2	<0.3	10	0.940	<2	139	<1	21	2.1	86	197
R01:4183	1320	1	<0.3	15	0.912	<2	134	<1	20	2.1	76	234
R01:4186	2550	2	0.4	18	0.889	4	132	<1	24	2.4	98	299
ECOKA-21A	3990	<1	<0.3	7	0.549	<2	60	<1	14	1.3	77	107
MAN-10B	4290	<1	<0.3	7	0.457	7	48	<1	12	1.1	57	91
MAN-36	2190	<1	<0.3	3	0.520	4	72	<1	8	0.7	79	68
MAN-60B	928	4	0.3	14	1.07	6	139	<1	25	2.4	102	269
MAN-76	7460	<1	<0.3	8	0.525	<2	53	<1	13	1.3	102	100
CG515	1170	2	<0.3	13	1.03	3	122	<1	22	1.9	85	140
MAN-78B	9310	1	<0.3	7	0.563	3	61	<1	13	1.3	77	110
MAN-76 R	7470	<1	<0.3	8	0.524	2	52	<1	13	1.3	98	97

Total Digestion: A 0.125 g pulp is gently heated in a mixture of HF/HNO3/HClO4 until dry and the residue is dissolved in dilute HNO3. The standard is CG515.





Saskatchewan  
Research Council

125-15 Innovation Boulevard, Saskatoon, SK Canada S7N 2X8 • Ph: 306-933-5400 Fax: 306-933-7446

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Email: [info@src.sk.ca](mailto:info@src.sk.ca)

Geoanalytical Group: 2006-660

## SRC Geoanalytical Laboratories

125 - 15 Innovation Blvd.  
Saskatoon, Saskatchewan  
S7N 2X8

June 05, 2006

Phone: (306) 933-8118

Fax: (306) 933-5656

### Neil Church

600 Parkridge St.  
Victoria, British Columbia V8Z 6N7

All reports are the confidential property of the clients. Publications of statements, conclusions or extracts from these reports are not permitted without the client's written permission.

This copy of results, constitutes the **final official report**. Geoanalytical Laboratories SRC's liability will be limited only to the final official report. It is the client's responsibility to ensure that all interpretation of analysis is done, using data from this report.

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Geoanalytical Laboratories SRC's liability, if any, will be limited to the cost of performing the analysis.

Reviewed by:

Chelsey Schneider

*Accreditation: ISO/IEC 17025*

Neil Church  
Attention:  
PO #/Project:  
Samples: 18

SRC Geoanalytic Laboratories  
125 - 15 Innovation Blvd., Saskatoon, Saskatchewan, S7N 2X8  
Tel: (306) 933-8118 Fax: (306) 933-5656 Email: geochem@src.sk.ca

Report No: 06-660  
Date: June 05, 2006

### ICP6.3 Total Digestion

#### Column Header Details

Silver in ppm (Ag)  
Aluminum in wt % (Al<sub>2</sub>O<sub>3</sub>)  
Barium in ppm (Ba)  
Beryllium in ppm (Be)  
Calcium in wt % (CaO)

Cadmium in ppm (Cd)  
Cerium in ppm (Ce)  
Cobalt in ppm (Co)  
Chromium in ppm (Cr)  
Copper in ppm (Cu)

Dysprosium in ppm (Dy)  
Erbium in ppm (Er)  
Europium in ppm (Eu)  
Iron in wt % (Fe<sub>2</sub>O<sub>3</sub>)  
Gallium in ppm (Ga)

Gadolinium in ppm (Gd)  
Hafnium in ppm (Hf)  
Holmium in ppm (Ho)  
Potassium in wt % (K<sub>2</sub>O)  
Lanthanum in ppm (La)

Lithium in ppm (Li)  
Magnesium in wt % (MgO)  
Manganese in wt % (MnO)  
Molybdenum in ppm (Mo)  
Sodium in wt % (Na<sub>2</sub>O)

Niobium in ppm (Nb)  
Neodymium in ppm (Nd)  
Nickel in ppm (Ni)  
Phosphorus in wt % (P<sub>2</sub>O<sub>5</sub>)  
Lead in ppm (Pb)

Praseodymium in ppm (Pr)  
Scandium in ppm (Sc)  
Samarium in ppm (Sm)  
Tin in ppm (Sn)  
Strontium in ppm (Sr)

Tantalum in ppm (Ta)  
Terbium in ppm (Tb)  
Thorium in ppm (Th)  
Titanium in wt % (TiO<sub>2</sub>)  
Uranium in ppm (U, ICP)

**SRC Geoanalytical Laboratories**

125 - 15 Innovation Blvd., Saskatoon, Saskatchewan, S7N 2X8

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Report No: 06-660

Date: June 05, 2006

Neil Church

Attention:

PO #/Project:

Samples: 18

**ICP6.3 Total Digestion**

Column Header Details

Vanadium in ppm (V)  
Tungsten in ppm (W)  
Yttrium in ppm (Y)  
Ytterbium in ppm (Yb)  
Zinc in ppm (Zn)

Zirconium in ppm (Zr)

1  
3  
1

SRC Geoanalytical Laboratories

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Report No: 06-660  
 Date: June 05, 2006

Neil Church  
 Attention:  
 PO #/Project:  
 Samples: 18

ICP6.3 Total Digestion

Sample Number	Ag ppm	Al2O3 wt %	Ba ppm	Be ppm	CaO wt %	Cd ppm	Ce ppm	Co ppm	Cr ppm	Cu ppm	Dy ppm	Er ppm	Eu ppm	Fe2O3 wt %	Ga ppm	Gd ppm	Hf ppm
CG515	<0.2	17.6	2190	1.9	4.72	0.9	158	17	121	3	3.5	2.5	2.5	7.33	21	5.3	4.2
10824M	0.3	15.0	754	1.1	8.96	0.6	57	45	269	229	2.6	3.1	2.0	13.3	22	3.3	3.8
18017M	<0.2	14.3	2220	3.3	6.67	0.8	110	24	400	51	3.8	2.9	2.3	7.08	18	6.5	5.7
18023M	<0.2	14.1	2380	3.0	6.02	0.6	107	26	389	51	3.9	2.9	2.2	7.64	18	6.1	5.5
24983M	<0.2	13.9	897	1.3	8.18	0.5	37	36	297	24	2.9	3.0	1.4	9.31	17	3.5	2.8
24984M	0.2	15.2	1600	2.1	6.57	0.6	88	22	208	14	4.6	3.5	2.0	8.65	18	5.3	7.3
24985M	<0.2	14.4	1010	1.5	8.06	0.7	38	22	191	20	2.9	2.8	1.5	8.24	17	3.6	3.0
24986M	<0.2	15.9	1390	1.8	6.81	0.7	65	16	67	10	4.0	3.2	1.8	8.29	19	4.2	5.6
24987M	<0.2	14.0	910	1.4	8.26	0.6	35	35	294	24	2.8	2.9	1.4	9.30	16	3.5	3.4
24988M	<0.2	14.2	926	1.3	7.97	0.7	37	23	184	19	3.2	2.9	1.5	8.39	15	3.6	3.7
24989M	<0.2	12.8	1010	1.4	6.49	0.8	32	35	261	22	2.5	2.6	1.3	8.64	12	3.1	3.4
24990M	<0.2	13.9	915	1.7	7.20	0.8	36	30	347	23	2.9	2.6	1.4	8.73	18	3.5	3.4
24991M	<0.2	14.4	1140	1.5	6.81	0.8	59	25	332	16	3.7	3.3	1.7	8.31	17	4.5	3.0
24992M	<0.2	15.4	1010	1.7	7.63	0.8	61	18	142	12	4.0	3.3	1.7	7.75	19	4.3	4.5
24993M	<0.2	12.7	985	1.4	8.06	0.4	50	49	745	80	3.0	3.0	1.6	10.3	15	4.7	3.6
24994M	<0.2	12.5	1820	1.5	8.02	0.4	34	39	249	24	2.6	2.8	1.3	9.14	13	3.0	3.3
24995M	<0.2	14.4	1080	1.5	8.00	1.0	39	22	184	20	3.2	2.9	1.5	8.16	15	3.7	3.5
24992M R	<0.2	15.3	1000	1.7	7.59	0.8	60	18	142	12	4.0	3.3	1.7	7.71	18	4.3	4.5

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SRC Geoanalytical Laboratories

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Report No: 06-660

Date: June 05, 2006

Neil Church

Attention:

PO #/Project:

Samples: 18

ICP6.3 Total Digestion

Sample Number	Ho ppm	K2O wt %	La ppm	Li ppm	MgO wt %	MnO wt %	Mo ppm	Na2O wt %	Nb ppm	Nd ppm	Ni ppm	P2O5 wt %	Pb ppm	Pr ppm	Sc ppm	Sm ppm	Sn ppm
CG515	1.3	3.25	89	29	2.78	0.074	<1	3.21	8	67	23	0.677	17	17	12	8.8	4
10824M	1.4	2.00	29	12	8.45	0.155	<1	4.25	14	37	191	0.786	10	7	23	5.4	5
18017M	1.3	5.68	62	26	6.13	0.162	<1	2.68	36	52	105	0.819	23	12	17	8.3	<1
18023M	1.3	6.16	60	25	6.95	0.119	<1	2.56	34	50	129	0.766	20	12	16	7.7	<1
24983M	1.2	2.64	20	14	10.9	0.151	<1	3.19	8	25	188	0.547	10	4	23	4.5	<1
24984M	1.5	4.45	48	13	6.14	0.123	<1	2.52	16	45	44	0.631	15	10	21	7.2	<1
24985M	1.1	3.01	20	12	6.18	0.159	<1	3.19	9	25	33	0.604	10	5	23	4.6	<1
24986M	1.3	3.81	37	13	4.47	0.123	<1	3.02	13	34	7	0.584	13	7	20	5.8	<1
24987M	1.2	2.72	19	14	10.9	0.150	<1	2.79	7	23	194	0.554	9	4	22	4.4	<1
24988M	1.2	3.71	21	13	7.25	0.119	<1	1.76	8	25	50	0.560	9	5	24	4.6	<1
24989M	1.0	2.93	18	17	10.9	0.137	<1	2.98	7	21	211	0.506	10	4	20	3.9	<1
24990M	1.1	2.94	20	11	7.50	0.109	<1	2.74	7	23	144	0.566	11	4	21	4.3	<1
24991M	1.5	3.53	33	13	7.88	0.139	<1	2.80	12	32	112	0.497	9	7	22	5.2	<1
24992M	1.4	3.40	33	15	5.30	0.120	<1	3.02	14	34	13	0.570	10	7	23	5.7	<1
24993M	1.3	2.46	28	16	14.4	0.159	<1	2.49	8	30	369	0.604	8	6	23	5.5	<1
24994M	1.1	2.28	19	14	11.2	0.142	<1	1.36	7	23	246	0.522	7	4	22	4.5	<1
24995M	1.2	3.97	21	18	6.23	0.104	<1	1.81	8	26	35	0.613	8	5	23	4.7	<1
24992M R	1.4	3.38	33	14	5.27	0.120	<1	3.01	14	33	13	0.567	10	7	23	5.6	<1

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Samples: 18

ICP6.3 Total Digestion

Sample Number	Sr ppm	Ta ppm	Tb ppm	Th ppm	TiO2 wt %	U, ICP ppm	V ppm	W ppm	Y ppm	Yb ppm	Zn ppm	Zr ppm
CG515	1170	<1	<0.3	13	1.07	4	126	1	21	1.9	87	152
10824M	1990	4	<0.3	1	2.91	13	347	<1	19	1.9	173	130
18017M	1270	2	0.6	12	1.08	8	183	<1	24	2.3	105	276
18023M	1600	4	<0.3	12	1.06	4	177	<1	23	2.2	93	256
24983M	928	4	<0.3	3	1.08	6	236	<1	21	2.3	111	114
24984M	1000	3	0.4	11	1.18	<2	213	<1	30	3.2	104	300
24985M	916	1	<0.3	3	1.17	2	253	<1	21	2.3	106	130
24986M	1050	1	<0.3	8	1.16	2	228	<1	27	2.9	102	230
24987M	1470	<1	<0.3	3	1.08	6	232	<1	21	2.2	109	116
24988M	1350	2	<0.3	3	1.13	2	241	<1	22	2.3	104	114
24989M	378	1	<0.3	3	0.981	3	203	<1	19	2.0	98	105
24990M	767	1	<0.3	3	0.976	5	203	<1	20	2.1	103	103
24991M	825	3	<0.3	6	1.16	<2	228	<1	26	2.7	101	95
24992M	896	<1	<0.3	6	1.25	2	244	<1	27	3.0	109	179
24993M	923	2	<0.3	4	1.14	<2	236	<1	23	2.4	111	133
24994M	1380	2	<0.3	3	1.00	<2	240	<1	20	2.1	104	108
24995M	2980	2	<0.3	3	1.13	3	230	<1	21	2.3	114	121
24992M R	891	<1	<0.3	6	1.25	2	243	<1	27	3.0	108	178

Total Digestion: A 0.125 g pulp is gently heated in a mixture of HF/HNO3/HClO4 until dry and the residue is dissolved in dilute HNO3. The standard is CG515.



**GEOANALYTICAL LABORATORIES**  
FEE SCHEDULE

**Sampling Supplies**

- Plastic Bags 6 mil 8" x 13"
- Plastic Bags 6 mil 12" x 20"
- Plastic Pails 5 gallon
- Kraft Paper Bags
- One Cubic Metre Kimberlite Bags (1.5 tonne capacity)
- Tyvek Bags 5 1/2" x 10 1/2"
- sample tags\*
- preaddressed shipping labels\*
- sample submittal form\*

\*Provided for your convenience at no charge

\*\* Radioactive Decontamination: \$65.00 per hour labour (average four hours). Minimum \$65.00 per radioactive shipment.

**4.0 ICP Analysis**

**General Information**

We provide several multi-element ICP packages for your convenience. We offer the economical, industry standard 30 element packages as well as a more comprehensive 55 element package with lower detection limits for selected elements. You have the option to choose some or all of the elements listed for maximum flexibility. Please inquire if you have special requirements.

**4.1 Digestions**

The aqua regia leach is by definition a "partial" digestion and technically, none of the elements listed will "totally" dissolve. Some elements such as Ag, As, Bi, Cd, Co, Cu, Hg, Mo, Mn, Ni, P, Pb, U, V and Zn will be very "near" to total dissolution. Other elements, marked with a Δ, are more refractory in nature and will only be partially dissolved. The tri-acid digestion will however, "totally" dissolve most elements since the crystalline matrix of the sample is destroyed. Occluded minerals in the matrix are exposed and dissolved by the acids. Only those elements found in refractory minerals may not be dissolved. These refractory elements are marked with a +.

Digestion		Aqua Regia Leach		Triacid Digestion	
ICP Package #		4.1	4.1T	4.2	4.2T
Element	Symbol	Detection Limit	Detection Limit	Detection Limit	Detection Limit
Aluminum	Al <sub>2</sub> O <sub>3</sub>	0.01% Δ	0.01% Δ	0.01% +	0.01% +
Antimony	Sb	1 ppm Δ	5 ppm Δ	-	-
Arsenic	As	1 ppm	5 ppm	-	-
Barium	Ba	1 ppm Δ	10 ppm Δ	1 ppm +	10 ppm +
Beryllium	Be	0.2 ppm Δ	0.5 ppm Δ	0.2 ppm	0.5 ppm
Bismuth	Bi	1 ppm	5 ppm	-	5 ppm
Cadmium	Cd	0.2 ppm	1 ppm	0.2 ppm	1 ppm
Calcium	CaO	0.01% Δ	0.01% Δ	0.01%	0.01%
Cerium	Ce	1 ppm Δ	-	1 ppm +	-
Chromium	Cr	1 ppm Δ	1 ppm Δ	1 ppm	1 ppm
Cobalt	Co	1 ppm	1 ppm	1 ppm	1 ppm
Copper	Cu	1 ppm	1 ppm	1 ppm	1 ppm
Dysprosium	Dy	0.2 ppm Δ	-	0.3 ppm	-



Digestion		Aqua Regia Leach		Triacid Digestion	
ICP Package #		4.1	4.1T	4.2	4.2T
Erbium	Er	0.2 ppm Δ	-	0.3 ppm	-
Europium	Eu	0.2 ppm Δ	-	0.3 ppm	-
Gadolinium	Gd	1 ppm Δ	-	1 ppm	-
Gallium	Ga	1 ppm Δ	-	1 ppm	-
Germanium	Ge	1 ppm Δ	-	-	-
Hafnium	Hf	1 ppm Δ	-	1 ppm +	-
Holmium	Ho	0.4 ppm Δ	-	0.5 ppm	-
Iron	Fe <sub>2</sub> O <sub>3</sub>	0.01% Δ	0.01% Δ	0.01%	0.01%
Lanthanum	La	1 ppm Δ	-	1 ppm	-
Lead	Pb	1 ppm	2 ppm	1 ppm	2 ppm
Lithium	Li	1 ppm Δ	-	1 ppm	-
Lutetium	Lu	0.2 ppm Δ	-	0.2 ppm	-
Magnesium	MgO	0.001% Δ	0.01% Δ	0.001% +	0.01% +
Manganese	MnO	0.001% Δ	0.001% Δ	0.001% +	0.001% +
Mercury	Hg	0.1 ppm	-	-	--
Molybdenum	Mo	1 ppm	2 ppm	1 ppm	2 ppm
Neodymium	Nd	1 ppm Δ	-	1 ppm	-
Nickel	Ni	1 ppm	1 ppm	1 ppm	1 ppm
Niobium	Nb	1 ppm Δ	-	1 ppm	-
Phosphorus	P <sub>2</sub> O <sub>5</sub>	0.001%	0.001%	0.001%	0.001%
Potassium	K <sub>2</sub> O	0.002% Δ	0.01% Δ	0.002%	0.01%
Praseodymium	Pr	1 ppm Δ	-	1 ppm	-
Samarium	Sm	1 ppm Δ	-	1 ppm	-
Scandium	Sc	1 ppm Δ	1 ppm Δ	1 ppm	-
Selenium	Se	1 ppm Δ	-	-	-
Silver	Ag	0.2 ppm	0.2 ppm	0.2 ppm	1 ppm
Sodium	Na <sub>2</sub> O	0.01% Δ	0.01% Δ	0.01%	0.01%
Strontium	Sr	1 ppm Δ	1 ppm Δ	1 ppm	1 ppm
Tantalum	Ta	1 ppm Δ	-	1 ppm	-
Tellurium	Te	1 ppm Δ	-	-	-
Terbium	Tb	0.3 ppm Δ	-	0.5 ppm	-
Thorium	Th	1 ppm Δ	-	2 ppm	-
Thulium	Tm	0.2 ppm Δ	-	0.3 ppm	-
Tin	Sn	1 ppm Δ	10 ppm Δ	1 ppm	-
Titanium	TiO <sub>2</sub>	0.002% Δ	0.01% Δ	0.002%	0.01%
Tungsten	W	1 ppm Δ	10 ppm Δ	2 ppm +	10 ppm +
Uranium	U	2 ppm	-	5 ppm	-
Vanadium	V	1 ppm	1 ppm	1 ppm	1 ppm
Ytterbium	Yb	0.2 ppm Δ	-	0.3 ppm	-
Yttrium	Y	1 ppm Δ	1 ppm Δ	1 ppm	-
Zinc	Zn	1 ppm	1 ppm	1 ppm	2 ppm
Zirconium	Zr	1 ppm Δ	1 ppm Δ	1 ppm +	-
Per Sample Cost		\$20.85	\$12.00	\$27.75	\$17.15

## Appendix D

### Statement of Qualifications

I, Barry Neil Church, do hereby certify that:

1. I am a member of the Association of Professional Engineers and Geoscientists of British Columbia (membership number #8172) with offices at 600 Parkridge St., Victoria, B.C.
2. I am a graduate of the University of British Columbia (1967) with a Ph.D. in geology. I have practiced my profession continuously since graduation.
3. I am familiar with the district. This report is based on my personal examination of the property during 2005. I am the author of this report and verify the costs as reported to be true.
4. F. Nidderly (Okanagan Falls, B.C.) and myself are the owners of the property.

Dated at Victoria, B.C., the 15<sup>th</sup> day of October, 2006

