



## Marilla Perlite - Volcanic Glass Occurrence, British Columbia

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### ABSTRACT

Perlite is a natural hydrated volcanic glass that displays concentric 'onion-skin-like' fractures in hand sample or in thin section. It can occur as silicic lava domes, lava flows, welded ash-flow tuffs, glassy plugs, laccoliths and dikes, but most commercial perlite production comes from domes. There are two main hydration processes of perlite. Primary hydration occurs during formation of the rock before it has cooled. Secondary hydration occurs after the rock has cooled and is the more important of the two processes. Perlite has a number of industrial and agricultural applications. There are at least 23 known occurrences in British Columbia, which are listed in MINFILE (a British Columbia computer based mineral inventory system). Currently there are no producing perlite mines in Canada.

The Marilla perlite occurrence is located approximately 170 km west of Prince George, directly south of Cheslatta Lake, and outcrops for 65 m along the eastern side of Marilla Road. It consists mainly of aphyric or porphyritic biotite-plagioclase-bearing rhyolite typical of the Ootsa Lake Group, which outcrops sporadically throughout the area. Geochemical analysis confirms that the six identified lithological units are rhyolite or rhyodacite in composition. Expansion tests, using a propane torch, showed at least some degree of expansion in each sample, with a boulder found near the occurrence expanding readily. This study confirms the exploration potential in the Prince George area for expanding perlite deposits, however the distance to the market should be taken into consideration during a conceptual study before selecting this area for a major exploration program.

### BACKGROUND INFORMATION

#### DEFINITION

Petrographically, perlite is defined as a hydrated natural rhyolite glass with perlitic texture (Bates and Jackson, 1987). It consists of 2-5% total water held within the glass structure, which is considerably higher than average obsidian water content. Industry defines perlite as any hydrated felsic rock which through rapid thermal expansion increases in volume to form a white porous lightweight cellular aggregate (McPhie *et al.*, 1993; Breese and Barker, 1994; Simandl *et al.*, 1996).

Perlite is expanded by heating crushed perlite rock to the softening temperature of glass in a furnace. At temperatures ranging from 870 to 1100°C the glass becomes soft

enough for the water it contains to expand into steam resulting in a cellular structure and an increase in volume of up to 20 times. The result is a frothy particle with extremely low density, high surface area and light or white colour (Breese and Barker, 1994).

### ORIGIN OF PERLITE

The water content of obsidian is typically less than 1 weight percent and is considered to be "primary" magmatic water. The higher water content of perlite (up to about 5%) is attributed to the addition of "secondary" water from external sources, such as ground water or surface water (Ross and Smith, 1955; Friedman *et al.*, 1966; Lofgren, 1971). Primary hydration occurs during the formation of a volcanic rock or glass until the first stages of metamorphogenic changes, or rock weathering, in which hydration becomes secondary (Nasedkin, 1988). Secondary hydration occurs after emplacement and late in the cooling history of the glass, or after complete cooling to surface temperatures (Nasedkin, 1988). Secondary hydration takes place at the conditions of zeolite facies in the processes of metamorphism and rock weathering (Nasedkin, 1988). Zeolite facies metamorphism and rock weathering typically occur below 2.5 kb and 300°C.

### PERLITE APPLICATIONS/USES

In the building and construction industry, expanded perlite is mixed in mortar, concrete and plaster to utilize its thermal, acoustic, lightweight and fire resistant properties. Its thermal insulation properties and low density make it highly effective in roof insulation board, pipe insulation, and refrigerator insulation. Its sonic insulation properties make it an ideal material for acoustical ceiling tile (Breese and Barker, 1994).

The ability of expanded perlite to retain water in its cellular structure makes it desirable in horticultural applications, and it is therefore used to condition soil. Expanded perlite adds loft, reduces compaction, and facilitates water drainage and moisture retention in soils due to its ability to retain water in its cellular structure (Simandl *et al.*, 1996). It is commonly used as a propagating medium for seedlings and for the packaging and storage of bulbs and plants

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(Breese and Barker, 1994). Expanded perlite can also be used as a substrate in hydroponic farming, and as a fertilizer-carrying matrix (Lin, 1989).

The internal cellular structure of expanded perlite makes it advantageous in filtration aids and oil absorbents. Expanded perlite offers high porosity and does not interfere chemically with the liquid filtered (Shackley and Allen, 1992).

Expanded perlite is used extensively in livestock applications, for the absorption of nutrients, liquid chemicals such as pesticides, fertilizers, oils, and pharmaceuticals. It is used as an additive in animal feed mixtures to aid in digestion and for growth promotion (Lin, 1989), and also can be used as an absorbent in litter padding for chicken coops (Lin, 1989).

Unexpanded perlite can be used in ceramics, glass, explosives as well as several other applications (Lin, 1998).

### GENERALIZED CHARACTERISTICS OF PERLITE DEPOSITS

Perlite has many modes of occurrence including silicic lava domes and lava flows, welded ash-flow tuffs, glassy plugs, laccoliths, and dikes (Breese and Barker, 1994). Most commercial production comes from flows associated with thick accumulations of tuffs and lava flows, and from lava domes (Chesterman, 1966).

A single perlite flow can range in thickness from less than a metre to several metres and may be traced along the length of the outcrop for more than a kilometer. Silicic lava flows commonly display internal textures and structures such as flow banding, aligned elongate phenocrysts, and stretched vesicles (McPhie *et al.*, 1993). Perlite domes can range from 100 m to 2 km in diameter, and can extend vertically more than 100 m from their base (Chesterman, 1966). Rhyolite domes are usually flat or gently sloping on the upper surfaces, with steep sides and flow fronts (Figure 1). Upper parts of the dome may exhibit steep flow foliations and ramp structures with ridges on the surface (McPhie *et al.*, 1993). These silicic lava flows and domes consist of a typical zonation shown in Figure 1, in which a texturally zoned exterior glass unit encompasses a partially devitrified and crystallized inner glass unit. This zonation is produced by rapid quenching of exterior surfaces and crystallization of the interior (Breese and Barker, 1994).

### PERLITE MARKETS

There are no producing perlite mines in Canada causing sized and expanded perlite to be imported mostly from the United States and Greece. Greece is by far the largest exporter of perlite, from its deposits on the island of Milos in the Aegean Sea (White, 2002). The United States exports about 10% of its production, the majority of which goes to Canada. Crushing and sizing is generally done at facilities located close to the pits. To reduce transportation costs the unexpanded perlite is shipped directly from the pits to local markets where it is expanded and processed for distribution to end users (Breese and Barker, 1994).

The total world production of perlite is over two million tonnes per year (Coope, 1999). The market value for high-quality raw perlite in British Columbia, Alberta, Washington, and N.W. Oregon in 1994 was estimated at \$2.9 million Canadian dollars, and the total market for perlite in the same region in 1994 was estimated at 42 000 tonnes (Gunning and McNeil, 1994). Of this amount, 35 000 tonnes were sized ore and 7 000 tonnes were expanded perlite. Coated perlite microspheres represented 2 700 tonnes and \$2.5 million Canadian dollars (Gunning and McNeil, 1994).

### PERLITE IN BRITISH COLUMBIA

There are at least 23 known perlite occurrences in BC, with the Prince George area hosting several of these occurrences within the Ootsa Lake Group, including the Marilla perlite occurrence (Figure 2). These occurrences are described in MINFILE (a computer based mineral inventory system) <www.em.gov.bc.ca/Mining/Geosurv/Minfile/search/>. Perlite resources in BC were previously described by White (1990), Morin and Lamothe (1991), Hora and Hancock (1995), Simandl *et al.* (1996) and White (in press). The Francois and Frenier deposits are two past producing perlite mines in British Columbia. Approximately 1589 tonnes were mined from Francois from 1949-1953 by Western Gypsum Products Ltd.. The Frenier deposit produced 6 000 tonnes of crude perlite from 1983 through 1985. The Frenier mine has been inactive since 1986 in part due to a low-capacity bridge across the Fraser River.

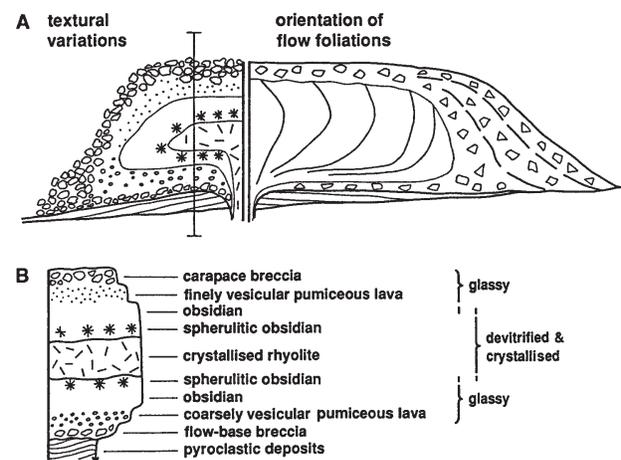


Figure 1. (A) Schematic cross-section through a subaerial silicic lava flow. The left side shows the internal textural variation arising from vesiculation, devitrification and flow fragmentation. The right side shows the orientations of internal flow foliations, and crude layering in flow margin talus breccia (B) Vertical section through the flow at the position indicated in (A), showing the major textural zones. Modified from Fink and Manley (1987) and Duffield and Dalrymple (1990). By McPhie *et al.*, (1993).



Figure 2. Location of perlite occurrences in BC listed in MINFILE <[www.em.gov.bc.ca/Mining/GeolSurv/Minfile/search/](http://www.em.gov.bc.ca/Mining/GeolSurv/Minfile/search/)> with location of the map shown in Figure 3. 1-Prospect Creek; 2-Empire Valley; 3-Moore Lake; 4-Frenier; 5-French Bar Creek; 6-Terrace Mountain; 7-Anahim Peak; 8-Nazko; 9-Tasalit Mountain; 10-Denny Island; 11-Lagoon Bay; 12-Ironside Mountain; 13-Coates Creek; 14-Skelu Bay; 15-Blackwater Creek; 16-Canoe Creek; 17-Ship Keita Island; 18-Juskatla Inlet; 19-Florence Creek; 20-Cheslatta Lake; 21-Henson Hills; 22-Uncha Lake; 23-Francois; 24-Marilla. Modified from White (2002).

## MARILLA PERLITE SHOWING

The Marilla perlite showing is located approximately 170 km west of Prince George, directly south of Cheslatta Lake N53° 42.588' and W125° 19.371' (Figures 2 and 3). It outcrops along the eastern side of Marilla Road for 65 m. The showing was mapped and sampled in 2000 by the British Columbia Geological Survey. The deposit consists mainly of an aphyric or porphyritic biotite-plagioclase-bearing rhyolite, typical of the Ootsa Lake Group as described by Duffell (1959), Tipper (1963), Diakow *et al.* (1997), and Grainger and Anderson (1999). The Ootsa Lake Group is composed of rhyolitic flows and domes, crystal and lithic-crystal tuffs, pyroclastic and autoclastic breccias, and minor dacite and andesite flows (Grainger and Anderson, 1999). The predominant rock type is a flow-laminated rhyolite, that occurs as flows and less commonly as domes. Its colour varies from red to white to grey, and locally purple or green. Textures within the Ootsa Lake group can vary within metres. Monolithic breccias, containing flow-laminated clasts, are found associated with rhyolite flows and domes. The rocks are aphyric or sparsely plagioclase-phyric. Biotite, alkali feldspar, quartz, and/or rare hornblende are minor phenocryst phases. Several exposures of buff, flow-laminated rocks have black, glassy, perlitic flow bases (Grainger and Anderson, 1999). The Ootsa Lake Group is host to occurrences such as the Cheslatta Lake, Henson Hills, Uncha Lake and

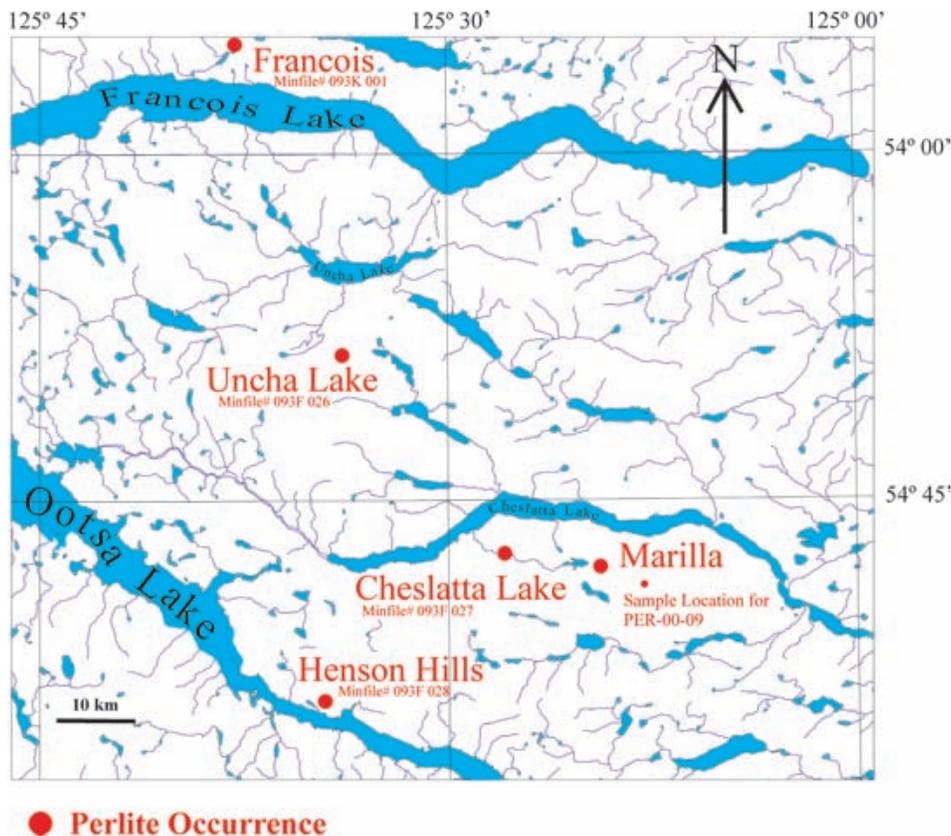


Figure 3. Perlite occurrences in the Prince George area Ootsa Lake Group with location of the newly discovered Marilla perlite occurrence. See Figure 2 for location of map within BC.

Francois occurrences, as well as the Marilla occurrence (Figure 3).

Six lithologies of the Marilla perlite showing were distinguished in the field (Figure 4). These are: Banded Spherulitic Rhyolite Breccia, Flow-Banded Perlite, Rhyolite with Biotite Phenocrysts, Spherulitic Amygdaloidal Perlite, Spherulitic Rhyolite, and a Grey Perlite Breccia described below. Sample MAR-00-09, from the Flow Banded Perlite unit, was taken from a loose angular boulder about one meter in diameter found on the roadside 200 m west of the showing. Sample PER-00-01, from the Perlite with Amoeba-like Spherulite unit, was taken from a small flat outcrop in the ditch approximately 4 km east of the Marilla perlite showing. The coordinates for this unit are N53° 42.211' and W125° 16.42'.

with beige bleaching in 2-3 mm thick zones. Common opal fills open spaces in the rock, with some opal forming veinlet swarms. Major constituents consist of 5-10% subhedral partially dissolved plagioclase grains averaging 1mm in diameter and 2% biotite averaging 0.8 mm in longest dimension. Spherulites make up 40-45% of the rock and are up to 1 cm in diameter, consisting of plagioclase microlites (Figure 5). The spherulite's brown colour is due to the presence of palagonite, which is a low temperature hydration and alteration mineral of sideromelane. Some spherulites are nucleated on plagioclase phenocrysts. Minor constituents are epidote (<1%, 0.25 mm in diameter) and iron oxides (2%) possibly consisting of hematite or magnetite and pyrite. There are relatively few plagioclase microlites in the glass matrix. Perlitic texture is common throughout the glass matrix. The rock expands by less than 30% when heated with a propane torch.

## PERLITE ROCK UNITS

### Banded Spherulitic Rhyolite Breccia (MAR-00-01)

This rock is layered grey and cream, with maroon spherulites on a fresh surface. Altered surfaces are grey

### Flow-Banded Perlite (MAR-00-02)

This unit is layered dark grey and orange/red with maroon spherulites. Layers are up to 3 cm thick, with flow banding and spherulites following the flow banding. There

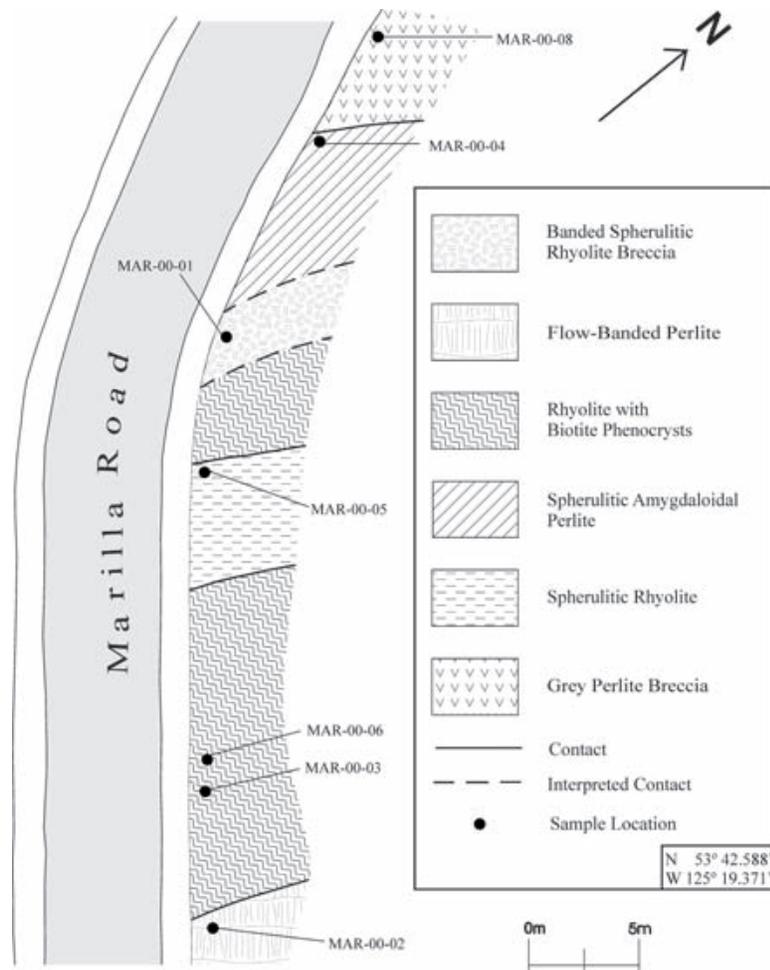


Figure 4. The Marilla perlite outcrop in plan view showing the six major lithological units.

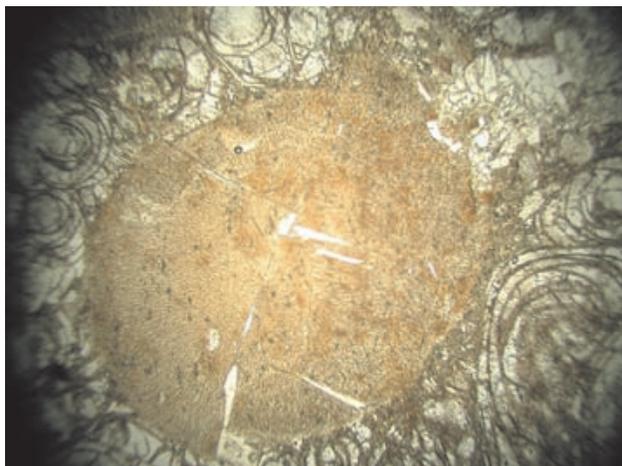


Figure 5. Spherulite of sample MAR-00-01 (Banded Spherulitic Rhyolite Breccia) in plane-polarized light.

is a pearly luster on the hackley glass fractured surface. Major constituents are spherulites (40%), which are up to 1 cm in diameter, subhedral partially dissolved plagioclase grains (5-10%) averaging 0.7 mm in diameter and biotite phenocrysts (2%) averaging 0.3 mm in longest dimension with some biotite phenocrysts reaching 0.9 mm in longest dimension. Minor constituents are opaques (<1%) averaging 0.08 mm in diameter, epidote (<1%) averaging 0.1 mm in diameter, and amygdules of silica, agate and common opal (1-2%) that averages 6 mm in longest dimension. Large areas of alteration are common, displaying remnant perlitic texture. The rock made some popping noises when heated with a propane torch, but expansion was minimal at less than 5%.

#### **Rhyolite with Biotite Phenocrysts (MAR-00-03)**

This rhyolite is beige/pink/grey with 2 mm black biotite phenocrysts that have a copper coloured reflection on a fresh surface. The altered surfaces appear lighter coloured than the fresh surfaces. Major constituents are plagioclase and orthoclase phenocrysts (5%) averaging 0.5 mm in diameter with some up to 2 mm, and bright orange/red coloured biotite (2%) averaging 0.25 mm in longest dimension. Amygdules (2%) infilled with carbonates that display fan textures are present and average 1.3 mm in longest dimension. Embayed feldspar grains are cemented with a glassy matrix, and fiamme texture is evident throughout the rock. No expansion was observed when heated with a propane torch.

#### **Spherulitic Amygdaloidal Perlite (MAR-00-04)**

This rock is dark grey/green with maroon spherulites averaging 0.5 cm in diameter on a fresh surface, and light brown and green with maroon spherulites exposed on a weathered surface. Major constituents are spherulites (85%) up to 0.75 cm in diameter, partially dissolved embayed plagioclase phenocrysts (8%) averaging 0.6 mm in diameter, and biotite (1%) averaging 0.2 mm in longest dimension. Minor constituents are epidote (<1%) averaging 0.5 mm in diameter, opaques (<1%) averaging 0.1 mm

in diameter, amygdules (1%) averaging 2 mm in diameter and swallow-tails of plagioclase (<1%). Most of the perlitic textured glass is altered and has been taken over by spherulitic texture. Most spherulites are round but some are fan or plumose shaped. The lighter coloured portion of the rock popped, but no evident expansion occurred when heated with a propane torch.

#### **Spherulitic Rhyolite (MAR-00-05)**

This rock is light grey with abundant maroon spherulites on a fresh surface. It breaks apart easily on altered surfaces due to fracture networking, beige bleaching and swarming of veinlets. No layering or banding is evident. Major constituents are spherulites (55%) up to 2.5 cm in diameter, partially dissolved plagioclase phenocrysts (7%) averaging 0.75 mm in diameter and biotite (2%) averaging 0.5 mm in longest dimension. Opaques (possibly hematite, magnetite or ilmanite) consist 1% and are 0.1 mm in diameter. The spherulites are nucleated mainly on plagioclase or biotite phenocrysts, and some have reaction rims between them and the glass. The glass matrix displays perlitic texture in which microlites have grown in the perlitic fractures (Figure 6). There was expansion of the rock by 35% when heated with a propane torch.

#### **Rhyolite with Biotite Phenocrysts (MAR-00-06)**

This sample was taken from the same lithological unit as sample Mar-00-03 (Rhyolite with Biotite Phenocrysts unit) and is similar in hand sample and thin section. The thin section has a slightly darker appearance in cross-polarized light than Mar-00-03, which may be the result of slightly more alteration, denser compaction, or a slightly thicker cut slide. Swallow-tails of plagioclase occur, and zoned feldspars are common. The rock expands by less than 3% when heated with a propane torch.

#### **Grey Perlite Breccia (MAR-00-08)**

On a fresh surface this rock has dark grey fragments averaging 2 cm in diameter surrounded by cream coloured matrix and smaller brecciated pieces of light grey rock. The

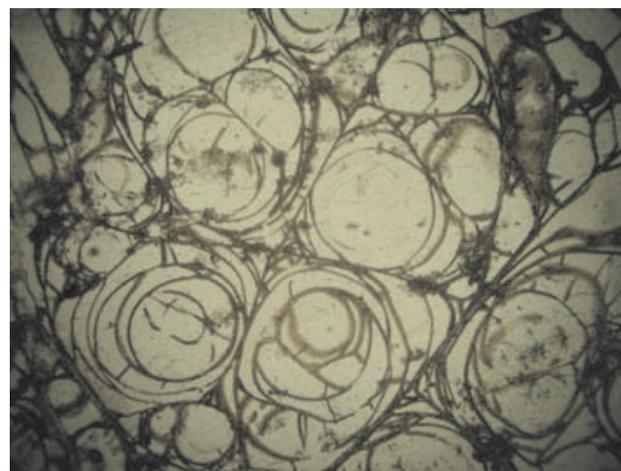


Figure 6. Perlitic fractures of sample MAR-00-05 (Spherulitic Rhyolite unit) in plane polarized light.

altered surface is beige/cream and light grey. Biotite phenocrysts, up to 1.5 mm in diameter, are present. Major constituents are partially dissolved plagioclase phenocrysts (3%) averaging 0.4 mm in diameter and biotite (1%) averaging 0.5 mm in longest dimension. Minor constituents are epidote (<1%) averaging 0.2 mm in diameter, and a feathery high birefringence fracture-filling mineral (possibly a chlorite/sericite mix). Brecciated unaltered glass occurs in 30% of the rock, averaging 1.0 cm in diameter, with altered lighter coloured glass surrounding it. Perlitic texture is evident throughout the glass, but slightly more alteration occurs in the darker coloured glass. Spherulites are present in their early stages of development as dark spots of alteration. The rock expands by 40% when heated with a propane torch.

#### **Flow Banded Perlitic Obsidian (MAR-00-09)**

This sample is from a boulder found on the roadside 200 metres west of the Marilla perlite showing. In hand sample, it is dark grey/green with black flow banding up to 3 mm in width. It has a pearly hackley/conchoidal fracture on a fresh surface and a beige/brown coating on an altered surface. Major constituents are partially dissolved feldspar phenocrysts (5%) averaging 1.0 mm in diameter, biotite (2%) averaging 0.1 mm in longest dimension, and amphibole (<1%), which is likely tremolite, averaging 0.1 mm in diameter. Minor constituents are opaques (<1%) averaging 0.2 mm in diameter, and veins of yellow alteration material (possibly clays, zeolites, or a mineral of the silica group). The flow banding appears to be speckled in thin section with remnant perlitic texture, and flows around plagioclase and other grains (Figure 7). The glass is relatively unaltered with abundant perlitic texture and makes up the majority of the rock (up to 90%). There are plagioclase hopper structures and swallow-tails, and some biotite hopper structures in the perlitic glass matrix. Small spherulites, in their first stages of growth, occur in 1% of the rock and average 0.4 mm in diameter. They radiate from plagioclase phenocrysts in fan and plumose structures. The rock expands several times its original volume when heated with a propane torch.



Figure 7. Flow banding in sample MAR-00-09 (Flow Banded Perlitic Obsidian unit) in plane polarized light.

#### **Perlite with Amoeba-like Spherulites (PER-00-01)**

This sample was taken from a small flat outcrop in the ditch approximately 4 km east on Marilla Road. The fresh surface is black/grey with purple amoeba-like spherulites up to 0.5 cm in diameter. The altered surface has a peach/green/yellow coating. Spherulites occur in 60% of the rock and have amoeba-like branches that radiate from a central point (Figure 8). Some spherulites are nucleated on plagioclase grains. Relatively few phenocrysts occur in the surrounding altered glass, which displays remnant and some perlitic texture. Phenocrysts include 3% plagioclase up to 2 mm in diameter, 1% biotite and <1% epidote. Vesicles in the glass are common. The rock expands by less than 3% when heated with a propane torch.

### ***GEOCHEMISTRY OF THE MARILLA PERLITE SHOWING***

All units of the Marilla perlite showing were identified as rhyolites in the field based on textures and structures. The major and minor element geochemistry of representative samples from the Marilla perlite showing was found using x-ray fluorescence and is given in Table 1. The SiO<sub>2</sub> content varies from 62.86% to 73.26% and the TiO<sub>2</sub> values are relatively low at 0.18% to 0.23%, which is indicative of rhyolite. The LOI (lost on ignition) values range from 3.2% to 4.15%. The Rhyolite with Biotite Phenocrysts sample (MAR-00-03) has a high LOI (15.53%), and a high CaO content (2.21%), reflecting carbonate in the amygdules. LOI of the Grey Perlite Breccia sample (MAR-00-08) has a value of 6.69%. It is assumed that a large portion of the LOI value is water incorporated into the glass structure, although it was not analyzed for.

Typical chemical compositions of perlite ores around the world and the average compositions of perlite and rhyolite are given for comparison to the Marilla perlite values (Table 1). This data shows that the TiO<sub>2</sub> and Fe<sub>2</sub>O<sub>3</sub> content of the Marilla perlite, averaging 0.23% and 1.2% respectively, is higher than other perlite ores around the world that

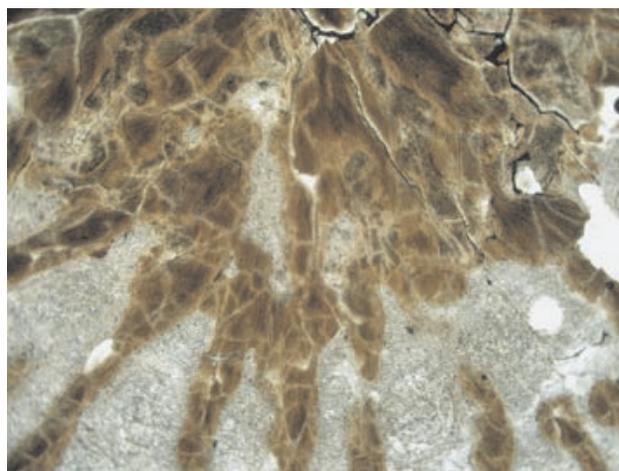


Figure 8. Spherulite in sample PER-00-01 (Perlite with Amoeba-like Spherulites unit) in plane polarized light.

**TABLE 1**  
**MAJOR AND MINOR ELEMENT GEOCHEMISTRY OF THE MARILLA PERLITE AREA**

**Marilla Perlite**

	SiO <sub>2</sub> %	TiO <sub>2</sub> %	Al <sub>2</sub> O <sub>3</sub> %	Fe <sub>2</sub> O <sub>3</sub> %	MnO %	MgO %	CaO %	Na <sub>2</sub> O %	K <sub>2</sub> O %	P <sub>2</sub> O <sub>5</sub> %	LOI %	Y ppm	Zr ppm	Nb ppm	Th ppm	Ti ppm	V ppm	Ba ppm	Hf ppm	
MAR-00-01	71.62	0.23	12.78	1.15	0.01	0.14	0.87	3.13	5.3	0.01	4.15									
MAR-00-02	72.33	0.23	13.05	1.4	0.01	0.18	0.82	3.18	5.28	0.01	3.08						10	967	4	
MAR-00-03	62.86	0.21	12.09	1.37	0.03	0.55	2.21	0.93	3.69	0.01	15.53	26	205	21	11	1250				
MAR-00-04	72.23	0.23	12.86	1.38	0.02	0.18	0.93	2.9	5.3	0.01	3.2	35	214	19	31	1378	11	1051	5	
MAR-00-05	71.65	0.23	13.03	1.25	0.01	0.17	0.87	3.05	5.07	0.01	4.15	31	221	20	18	1370	8	1046	5	
MAR-00-08	69.83	0.21	12.6	1.15	0.02	0.25	1.1	2.47	5.13	0.01	6.69	35	207	20	19	1200	8	1050	5	
MAR-00-09*	71.51	0.23	12.75	1.34	0.02	0.18	0.77	3.06	5.36	0.01	4.13									
PER-00-01**	73.26	0.18	12.35	1.02	0.03	0.12	0.69	2.98	5.34	0.01	3.48									

\*boulder found 200m west of the Marilla perlite showing

\*\*sample from approximately 4km east along Marilla Road from a small flat outcrop in the ditch (N53°42.211' W125°16.42') see Figure1b.

**Other Perlite Ores Around the World**

	SiO <sub>2</sub> %	TiO <sub>2</sub> %	Al <sub>2</sub> O <sub>3</sub> %	Fe <sub>2</sub> O <sub>3</sub> %	MnO %	MgO %	CaO %	Na <sub>2</sub> O %	K <sub>2</sub> O %	P <sub>2</sub> O <sub>5</sub> %	LOI %
No Agua, NM+	72.1	0.06	13.5	0.8		0.5	0.89	4.6	4.4		3
Superior, AZ+	73.6	0.1	12.7	0.7		0.2	0.6	3.2	5		3.8
Pioche, NV+	73.1	0.08	12.8	0.7		0.2	0.9	3	4.7		3.9
Big Pine, CA+	73.6	0.07	13.2	0.8		0.1	0.6	4.1	4.1		3.3
Milos, Greece+	74.2	0.08	12.3	0.95		0.13	0.85	4	4.4		2.8
Akita, Japan+	74.2	0.06	12.9	0.68		0.05	0.45	4.1	4		3.3
Bulgaria+	73.8	0.07	12.8	0.56		0.03	0.5	3	4.9		4
Argentina+	72.3	0.08	13.4	1		0.3	0.59	3.4	4.7		3.7
Hungary+	73.5	-	13	1.8		0.4	1.5	3.5	3.8		3
Average Chemical Composition of Perlite <sup>Δ</sup>	72.70	0.91	12.91	1.35	0.05	0.23	0.82	3.07	4.73	0.04	3.19
Average Chemical Composition of Rhyolite <sup>Δ</sup>	72.82	0.28	13.27	2.58	0.07	0.39	1.57	3.55	4.30	0.07	1.10

+Taken from Breese and Barker (1994), source Kadey Jr., (1983).

<sup>Δ</sup>from Shackley and Allen, (1992). Based on 50 perlite samples examined by Shackley (1989) and 60 rhyolite samples examined by Le Maitre (1976).

Method of analysis was x-ray fluorescence. Typical chemical compositions of perlite ores and average compositions of perlite and rhyolite are given for comparison to the Marilla perlite values.

average 0.07% and 0.8% respectively (Breese and Barker, 1994).

Method of analysis was x-ray fluorescence. Typical chemical compositions of perlite ores and average compositions of perlite and rhyolite are given for comparison to the Marilla perlite values.

Major and minor elements are plotted on three different discrimination diagrams (Figures 9, 10, and 11). The %SiO<sub>2</sub> - (%Na<sub>2</sub>O+%K<sub>2</sub>O) diagram shows all units plotting in the rhyolite field with the exception of the Rhyolite with Biotite Phenocrysts unit (sample MAR-00-03). This unit contains carbonate amygdules and falls into the dacite field (Figure 9). The samples taken from the Marilla perlite showing were relatively pristine with little alteration. Due to this, the major element plot of %SiO<sub>2</sub> - (%Na<sub>2</sub>O+%K<sub>2</sub>O) is considered to be accurate in the classification of most units being rhyolite.

Four of the eight samples were sent for trace element analyses (Table 1). These samples are plotted on a Zr/TiO<sub>2</sub> - %SiO<sub>2</sub> graph (Figure 10). Three of these samples plotted in the rhyodacite-dacite field with one sample falling in the trachyte field. The same four samples were also plotted on a Nb/Y - Zr/TiO<sub>2</sub> graph (Figure 11). This plot shows all the samples falling near the rhyolite, rhyodacite/dacite, and trachy-andesite boundaries. Diagrams using immobile element ratios such as Nb/Y and Zr/TiO<sub>2</sub> are useful in determining the original composition of volcanic rocks affected by alteration. Elements such as Zr, Ti, Nb, and Y are relatively immobile and remain in the rock when alteration occurs.

## ECONOMIC POTENTIAL

Subject to a torch flame, most samples display at least some degree of expansion. More rigorous testing using standard laboratory equipment is needed before confirming the potential as raw material for an expanding perlite plant.

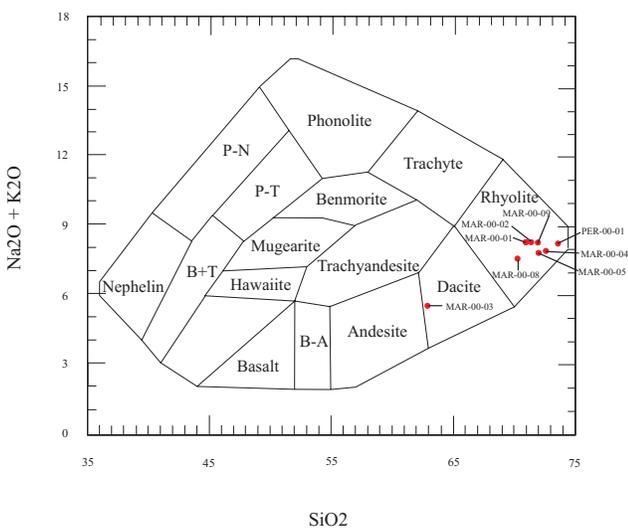


Figure 9. {%SiO<sub>2</sub> - (%Na<sub>2</sub>O+%K<sub>2</sub>O)} discrimination diagram for volcanic rocks, (Cox *et al.*, 1979).

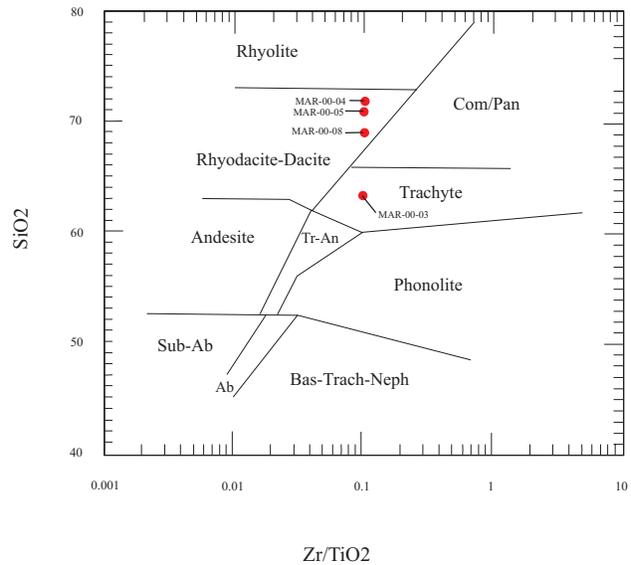


Figure 10. (Zr/TiO<sub>2</sub> - %SiO<sub>2</sub>) discrimination diagram for volcanic rocks. Abbreviations: Com = comendite, Pan = pantellerite, TrAn = Trachy Andesite, Ab = andesite basalt, Bas-Trach-Neph = basalt/trachyte/nephelinite (Winchester and Floyd, 1977).

The *Flow Banded Perlitic Obsidian* unit (sample MAR-00-09 from the boulder found 200m west of the showing), expanded to about 75%, which merits special attention. It is possible that the source of this perlite, or more highly expanding perlite, may be found in the area covered by overburden. The direction of ice flow during the last glaciation was estimated at 66° NE (Plouffe, 1999), and the angularity of this boulder suggests the source of the *Flow Banded Perlitic Obsidian* boulder (sample MAR-00-09) would lie relatively nearby, and southwest of the Marilla perlite showing.

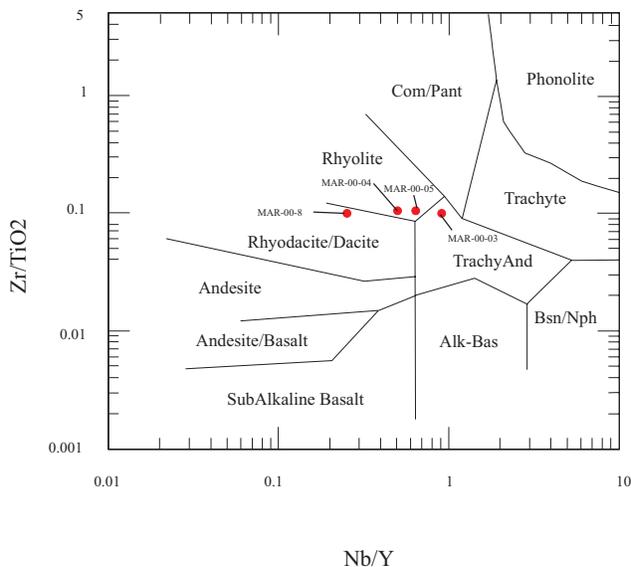


Figure 11. (Nb/Y - Zr/TiO<sub>2</sub>) discrimination diagram for volcanic rocks. Abbreviations: Com = comendite, Pant = pantellerite, Bsn = basanite, Nph = nephelinite, Alk-Bas = alkali basalt (Winchester and Floyd, 1977).

Testing of known volcanic glass occurrences and exploration in the Ootsa Lake Group is justified as it is a favourable host for expandable perlite. The Francois occurrence (Figure 3) has proven that perlite satisfying industry specifications can be found in the Prince George area. Approximately 1589 tonnes were mined from 1949-1953 by Western Gypsum Products Ltd.. Several of the volcanic glass and perlite localities in this area have been previously described by Tipper (1963), Duffell (1959), Granger and Anderson (1999), White (1990) and White (in press). Distance of the deposit from perlite consumers should be taken into consideration before investing heavily into exploration of this geologically favourable area, as a potential source of expanding perlite may be found closer to the market.

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