

# TESTING ON PERLITE AND VERMICULITE SAMPLES FROM BRITISH COLUMBIA

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**KEYWORDS:** Industrial minerals, perlite, vermiculite, thermogravimetric balance, softening-point temperature, bulk density, exfoliation tests.

## INTRODUCTION

In November 1989, CANMET was approached by the British Columbia Ministry of Energy, Mines and Petroleum Resources to perform an assessment of potential perlite and vermiculite resources, as represented by samples provided to us. The samples, totalling 520 kilograms, were from seven perlite occurrences (the Frenier deposit on the eastern slope of Blackdome Mountain, northwest of Clinton; the Francois Lake, Ootsa Lake and Uncha Lake prospects south of Burns Lake; and the Blackwater Creek, Florence Creek and Gold Creek occurrences in the Port Clements area of the Queen Charlotte Islands) and two vermiculite prospects (the Joseph Lake occurrence southeast of Fraser Lake and the Sowchea Creek showing near Fort St. James). The material for testing, as received, was a mixture of grab samples and chunk specimens shipped in jute bags. Brief descriptions of the geology of the sample sites are given by White (1990).

## TESTING ON SAMPLES OF PERLITE

### PREPARATION OF HEAD SAMPLE

Because of the nature of the material, a preliminary examination was made by removing a scoopful of material from each bag and combining the scoops as one lot weighing approximately 2 kilograms. This composite was reduced to less than 6 millimetres (1/4 inch) in a jaw crusher. A 100-gram sample was riffled and pulverized for thermal testing in a thermogravimetric balance. The rest of the material was used for subsequent beneficiation studies.

### DESCRIPTION OF TESTING

The samples were subjected to three tests. The first used the thermogravimetric balance to determine the percentage water loss when heated to about 800°C. In the second test the samples were heated under a heating microscope for determination of the softening point and the results were used in the subsequent thermal treatment. Thermal treatment involved heating the sample to 700°C in a horizontal stationary furnace for 5 minutes, then transferring it to a vibrating tube furnace set at the softening-point temperature. The small tube furnace, measuring 15 by 30 inches (≈40 by 80 cm) was set at an angle of 50° to the horizontal, with a stainless steel tube 48 inches (≈120 cm) long and 2 inches (≈5 cm) in diameter, centred within it. The total time for the material to pass through the tube was about 15 seconds, the retention time in the hot zone being about

5 seconds. A portion of the sample from each of the deposits was passed through the tube. The approximate bulk density of the material recovered from each test was obtained by measuring the weight in a 250 cubic centimetre graduate cylinder.

## RESULTS AND DISCUSSION

### THERMOGRAVIMETRIC BALANCE

Figure 3-1-1 shows that samples from Uncha Lake, Ootsa Lake, Francois Lake and Blackwater Creek are quite comparable to the sample from the Frenier deposit. The Gold Creek sample showed much higher weight loss (7.9%) than the Frenier sample (3.6%). The lowest water loss, the Florence Creek sample, was only 1.2 per cent.

### SOFTENING-POINT TEMPERATURE

Figure 3-1-2 shows softening-point temperatures; the Florence Creek sample was found to soften at the lowest temperature, between 1210 and 1235°C. Softening of the Gold Creek perlite occurred between 1235 and 1270°C, comparable to the Frenier perlite and other samples. Plate 3-1-1 is a series of photomicrographs illustrating the stages in the softening process.

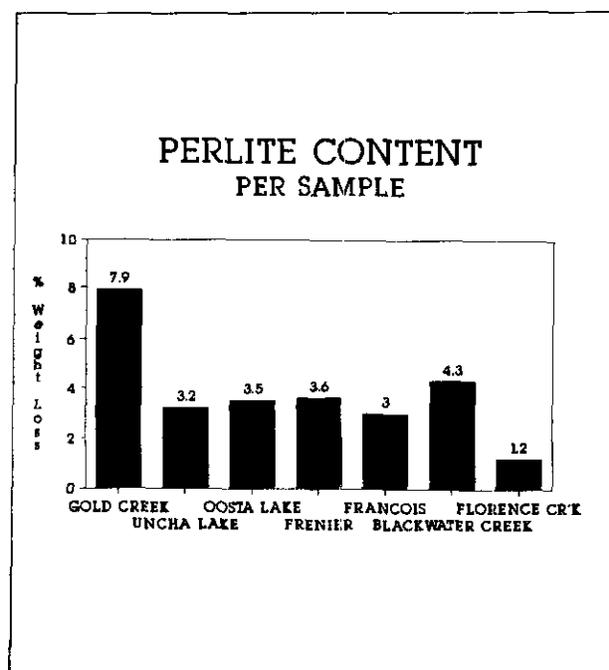
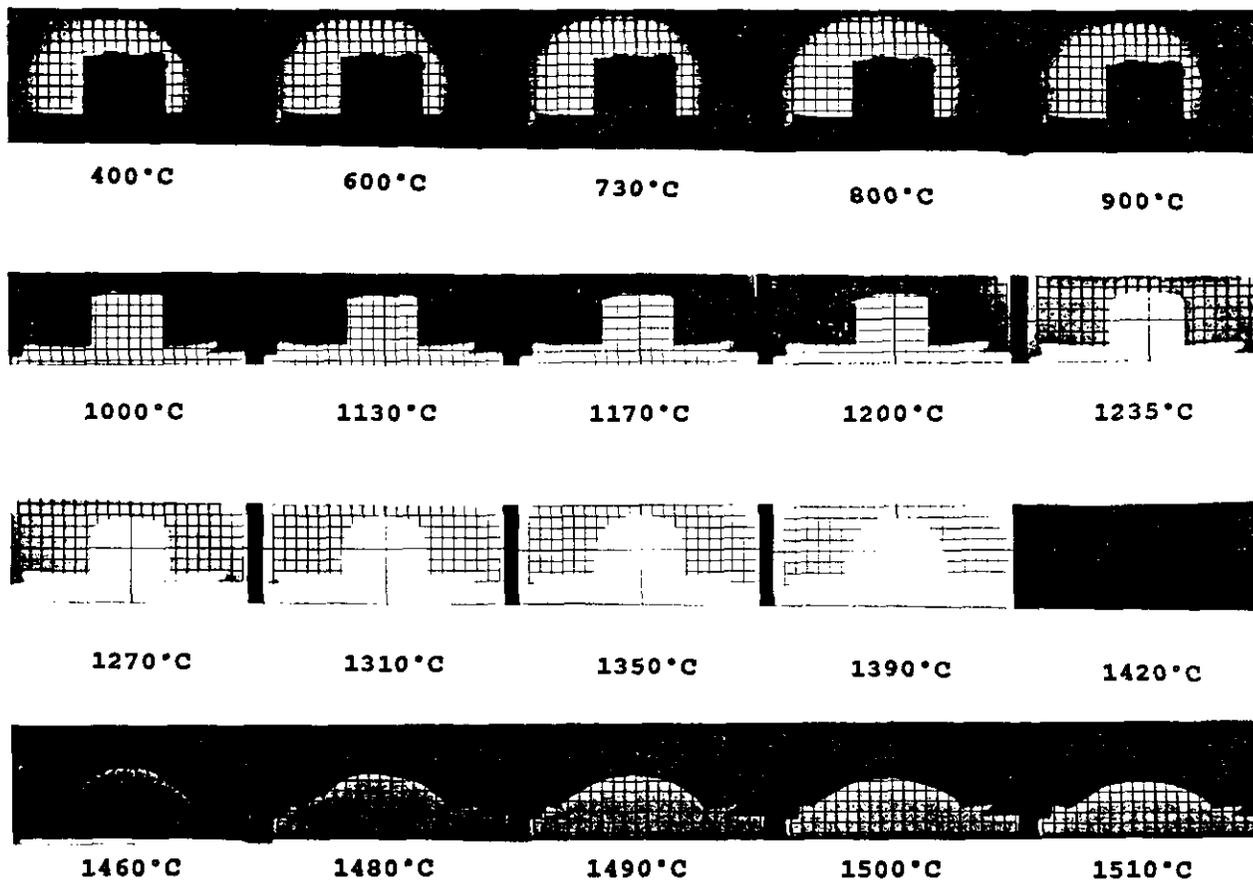


Figure 3-1-1. Histogram showing perlite content of samples from Gold Creek, Uncha Lake, Ootsa Lake, Frenier, Francois Lake, Blackwater Creek and Florence Creek.



## REPORT OF A SERIES OF PHOTOMICROGRAPHS

Material: Perlite, Gold Creek  
 Film: PX-125  
 Developed with: D-76, 5 min.  
 Printed with: Dektol 112

Date: May 3/1990

Velox paper F-3 for contact printing

Shot No	Time	Temperature	Light	Filter	Remarks
1	9:30	400	4	0	
2	9:48	600	4	0	
3	9:57	730	4	0	
4	10:02	800	4	0	
5	10:10	900	4	0	
6	10:18	1000	4	0	
7	10:25	1130	2	0	
8	10:33	1170	2	0	
9	10:35	1200	2	0	
10	10:38	1235	2	0	
11	10:41	1270	2	0	corner start rounded
12	10:44	1310	2	0	
13	10:49	1350	0	0	
14	10:53	1390	0	0	
15	10:56	1420	0	GREEN	hemisphere point
16	11:00	1460	0	GREEN	
17	11:04	1480	0	GREEN	
18	11:05	1490	0	GREEN	
19	11:06	1500	0	GREEN	
20	11:07	1510	0	GREEN	

Plate 3-1-1. Photomicrographs showing silhouettes of a perlite sample under heating treatment. At 1270°C the outline of the silhouette has rounded, indicating that at this stage the ashes have passed into the softening phase. The softening temperature is found to be between 1235 and 1270°C. After swelling slightly at 1350°C, the specimen eventually melts. The photomicrograph obtained at 1420°C shows the "hemisphere point", which is accepted as the melting point.

## HEATING TREATMENT

The results of the third test are illustrated by Figures 3-1-3 and 4. The Gold Creek sample expanded the most, decreasing to a bulk density of 166 kilograms per cubic metre. Bulk densities of expanded Frenier and Blackwater Creek perlite were 258 and 450 kilograms per cubic metre respectively and the Florence Creek sample gave the highest value (928 kg/m<sup>3</sup>).

## CONCLUSIONS

All results indicate that samples from Gold Creek and Florence Creek are significantly different from all other samples. The Gold Creek sample showed much higher water loss and was noticeably more expansible than all other samples. The Florence Creek sample shows very much lower water loss than the other samples and had the highest bulk density after the heating treatment. The other four perlite samples show similar and comparable results.

The temperature of the furnace could not be controlled as closely as desired to permit uniform heat treatment and the firing conditions were therefore not necessarily those which would give the best results. Considering this, the Gold Creek sample has the best potential application as filler, and possibly in concrete and plaster aggregates. Further testing, using equipment permitting an optimum heat treatment, might give better results and would be necessary to measure the actual potential of all the sampled deposits.

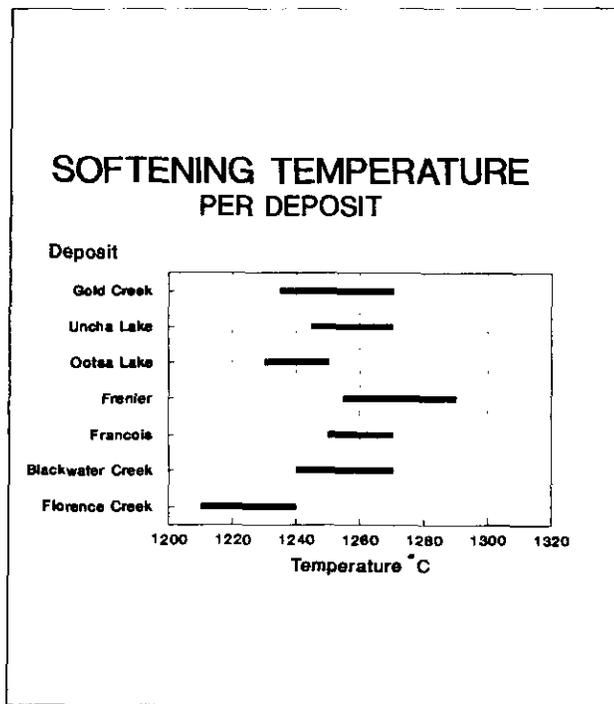


Figure 3-1-2. Softening temperatures of perlite samples from Gold Creek, Uncha Lake, Ootsa Lake, Frenier, Francois Lake, Blackwater Creek and Florence Creek.

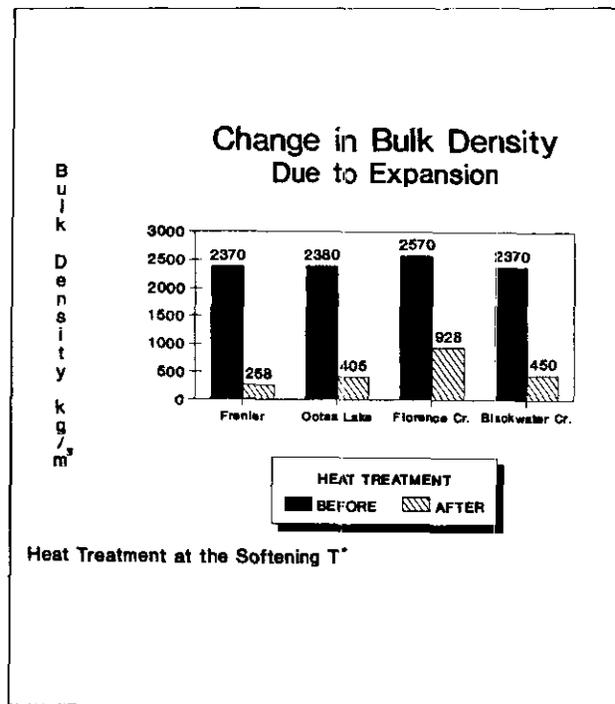


Figure 3-1-3. Change in bulk density due to expansion of perlite samples from Gold Creek, Uncha Lake, Frenier and Francois Lake.

## TESTING ON SAMPLES OF VERMICULITE

### PREPARATION OF HEAD SAMPLE

Five kilograms of material from each sample was riffled down to a 1-kilogram portion which was scrubbed in a Wemco attrition scrubber for 10 minutes at 20 per cent solids. After scrubbing, the samples were wet screened over an 8 mesh screen and crushed in a roll crusher to less than 3.36 millimetres ( $\approx 1/8$  inch).

### DESCRIPTION OF TESTING

The vermiculite samples were subjected to exfoliation tests using the same small tube furnace as for the tests on the perlite samples. The total time for the material to pass through the furnace, and the retention time in the hot zone, were the same as in the perlite tests. A portion of each size fraction was passed through the tube with the maximum temperature of the furnace maintained between 930 and 960°C.

### RESULTS AND DISCUSSION

Each product contained material that did not exfoliate and which was removed from the sample by air separation using an air table. The percentage by weight of vermiculite was calculated and an approximate density of the exfoliated vermiculite obtained (Tables 3-1-1 and 3-1-2). Figures in brackets under the heading "Vermiculite %" in the tables

TABLE 3-1-1  
EXFOLIATION TESTS ON SOWCHEA CREEK SAMPLE

Size Fraction mm	Product Wt %	Vermiculite %		Bulk Density (kg/m <sup>3</sup> ) (lb/ft <sup>3</sup> )	
-3.36+2.38	5	( 7.2)*	0.4	308	19
-2.38+1.65	4	(20.6)	0.9	267	17
-1.65+1.40	11	(22.9)	2.5	382	24
-1.40+800 $\mu$ m	27	(12.4)	3.3	413	26
-800+630 $\mu$ m	39	( 8.6)	3.3	357	22
-630+500 $\mu$ m	14	(10.2)	1.4	434	27
<b>Total</b>	<b>100</b>		<b>11.8</b>		

The vermiculite obtained from Sowchea Creek sample was dark golden-brown in colour, and was fairly well exfoliated. The plus 500  $\mu$ m (35 mesh) portion of the sample contained 11.8% vermiculite.

TABLE 3-1-2  
EXFOLIATION TESTS ON JOSEPH LAKE SAMPLE

Size Fraction mm	Product Wt %	Vermiculite %		Bulk Density (kg/m <sup>3</sup> ) (lb/ft <sup>3</sup> )	
-3.36+2.38	2	(0.1)	0.0	—	—
-2.38+1.65	3	(0.3)	0.1	—	—
-1.65+1.40	8	(0.5)	0.4	—	—
-1.40+800 $\mu$ m	28	(2.4)	0.7	398	25
-800+630 $\mu$ m	43	(7.9)	3.4	427	27
-630+500 $\mu$ m	16	(5.9)	1.0	326	20
<b>Total</b>	<b>100</b>		<b>5.6</b>		

\* Figures in brackets under the heading "% Vermiculite" are the percentage of vermiculite in each fraction.

are the percentage of vermiculite in the whole minus 3.36 millimetres fraction. The +500-micron fraction (35 mesh) had been discarded because of its lack of commercial value and the percentages were recalculated on the basis of grading the material to obtain the total percentage of vermiculite in the whole - 3.36-millimetre fraction.

As in the case of the perlite tests, the conditions of crushing and exfoliation were not necessarily those that would give optimum exfoliation and recovery of vermiculite.

## CONCLUSIONS

Neither of the samples tested shows significant promise of being suitable for use as loose insulation as both are too fine grained. More than 60 per cent of Canadian production was used for this purpose in 1980. Bulk densities greatly exceed ASTM specifications for this application which are in the range 88 to 128 kilograms per cubic metre.

The material tested might be used in other ways, such as filler or aggregates in insulating concrete or plaster, although the maximum bulk density permitted by ASTM specifications for lightweight aggregates in insulating concrete is 160 kilograms per cubic metre. The Sowchea Creek sample contained the most vermiculite, but the density obtained in these preliminary tests was not close enough to the specified limit to indicate that the material might be suitable for commercial purposes. The vermiculite content of the Joseph Lake sample appears to be too low to be of commercial value.

## REFERENCES

- White, G.V. (1990): Perlite and Vermiculite Occurrences in British Columbia; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork 1989, Paper 1990-1, pages 481-487.