Diatomite Resource Assessment in the Quesnel Area, Central British Columbia (NTS 093B/10E; 093G/2E)

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INTRODUCTION

The presence of diatomite in the Quesnel area has been known since 1877 (Dawson, 1877). Over the years, the diatomite deposits have been subjected to a number of examinations by both government agencies and industry. Some examples of work are Reinecke (1920), Eardly-Wilmot (1928), Cummings (1948) and McCammon (1960). In 1963, Godfrey prepared several unpublished geological reports for Pacific Diatomite Ltd. of Edmonton (Godfrey, 1963), and Visman and Picard (1969) focused on a new process for the beneficiation of Quesnel diatomite. In 1994, Hora and Hancock sampled diatomite outcrops in the Quesnel area as part of an industrial minerals assessment (Hora and Hancock, 1995). The analytical results that followed this assessment provide the basis for this paper. In the western United States, similar deposits were subject to extensive processing studies by the United States Bureau of Mines (Skinner et al., 1944) before being developed by the industry into high-value products.

HISTORY OF DIATOMITE DEVELOPMENT IN THE QUESNEL AREA

From 1937 until 1969, Fairey and Cunliff, later Fairey and Co. Ltd. of Vancouver, used the diatomite from Quesnel (Lot 6182 north of Quesnel airport) for insulation, ceramic products and pozzolanic cement admixtures.

Considerable effort was expended between 1938 and 1942 to develop the diatomite from the Buck Ridge area south of Quesnel. Work was initiated by the owner, P.G. Lepetich, with the assistance of the BC Ministry of Energy, Mines and Petroleum Resources with the goal of producing diatomite suitable for mineral fillers and filtration products, but without any success.

In 1963, Crownite Diatoms Ltd. of Calgary began development of a pit on the western edge of Quesnel (Lot 906) and construction of a processing plant near the confluence of the Fraser and Quesnel rivers. Their main products were industrial and domestic absorbents and anti-caking agents for fertilizer pellets. In 1982, the plant was relocated adjacent to the pit site and operated briefly under the name Microsil Industrial Minerals Ltd. Competition from Western Clay Products of Kamloops and an inadequate marketing strategy were two factors that contributed to the closure of the Quesnel plant and pit in 1984.

During the 1990s, regular shipments of diatomite were made from a pit opened on Lot 1615 in the Buck Ridge area by Clayburn Industries Ltd. (Fig 1). Clayburn, based in

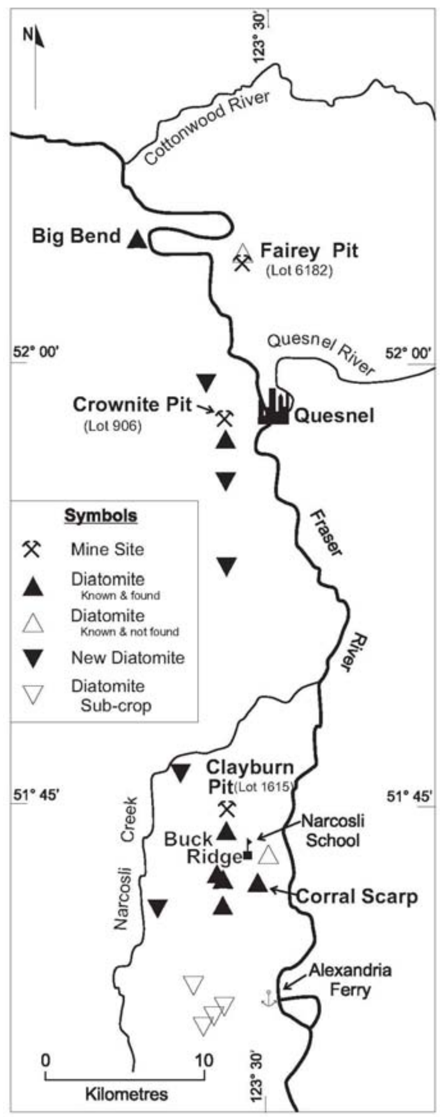

Figure 1. Location map of the study area.

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Abbotsford, BC, shipped small quantities of diatomite from the pit to its plant to manufacture several grades of insulation bricks for several years between 1990 and 1998. More economical diatomite imports from the United States was one of the factors that contributed to the discontinuation of this small-scale mining operation. At present, both pits on Lots 906 and 1615 are recontoured and reclaimed.

DIATOMITE DEPOSITS

Geology

Quesnel diatomite has been described as the Crownite Formation (Rouse and Mathews, 1979). It is a horizontal layer of diatomaceous earth, approximately 12 m thick, of Middle to Late Miocene age, between 13 and 8 Ma. Diatom species contained within include *Melosira pancipunctata, Melosira granulata, Melositra undulata, Fragilaria virescense, Cascinodiscus punctuatus* and *Eurinella sp*, which were identified by Rouse (1959).

The Crownite Formation is the youngest of the Miocene sedimentary units in the area and is underlain by the Fraser Bend Formation (Rouse and Matthews, 1979). Fraser Bend sedimentary rocks consist of mostly gravel in the lower 50 m and alternating sand, silt, clay and fine gravel in the upper 90 m.

The Crownite Formation is overlain by the Chilcotin basalt of the Late Miocene. The basalt forms a solid cap to many diatomite sections between the town of Quesnel and the Alexandria ferry, ~50 km to the south. Columnar jointing, pillow lava and palagonite breccia are common features of the basalt cap.

Diatomite is found in numerous showings over the entire distance west of the Fraser River between the site of the original diatomite discovery on the Blackwater River (Lot 1469, southeast corner; Dawson, 1877) and the Alexandria ferry (Fig 1). Most are minor exposures in roadcuts, gullies, slide scarps and animal burrows. The best exposures are in the areas of Big Bend, the Crownite pit on Lot 906 and the Clayburn pit on Lot 1615.

Diatomite beds are not uniform in appearance. Some of the layers are massive, while others are broken into small angular fragments 5 to 10 cm in size. The colour is generally pale beige to white, with various darker and lighter shades. Neither fracture density nor colour seem to correlate with chemical composition. There is a rusty weathering, harder and denser bed about 20 cm thick in approximately the middle of the unit, identified by McCammon (1960) as pumicite with some diatoms and silt. This layer has been found in a number of sites in the Quesnel area and may be considered a marker horizon representing a volcanic event that occurred during the deposition of the Crownite Formation.

Reported analytical data from grab samples during previous studies indicate that diatoms constitute some 75 to 80% of unprocessed diatomaceous earth. Between 7 and 11% of the samples is Al_2O_3, which is due to the presence of clay and volcanic ash (McCammon, 1960). Because of such variability in impurities, selective mining may be necessary. If so, Al_2O_3 distribution must be determined; therefore, available exposures were systematically channel sampled over all accessible thicknesses. Three sites were available for such sampling: natural exposures in the Big Bend area, the Crownite pit and the Clayburn pit. Samples were collected from hammer and shovel-cut channels in 50 cm segments from beds with uniform appearance, or in shorter segments in the cases of sudden changes in colour or density of the sediment.

The entire Miocene sequence has been subjected to extensive gravitational block sliding that is best observed on the western side of the Fraser River between Big Bend and Alexandria. The diatomite exposures have been mildly disturbed, apparently by motion on extensive fault blocks, many of which affect the whole Miocene sedimentary sequence and are presently active. Some slide blocks, particularly in the area between Narcosli Creek and Fraser River south of Quesnel, are several kilometres in length and up to 300 m wide. The vertical displacement of individual blocks, as observed from recently active scarps, has been from 1 to 2 m, up to more than 10 m. The diatomite has, therefore, been exposed at different elevations, leading to greatly overestimated thicknesses in the past. It is apparent that practically the entire area is encompassed by a massive slide zone parallel to the river. Although the slide blocks show signs of being recently active, many farm buildings and residences constructed on them do not appear to have foundation problems. The slides, which probably developed within the last 10 000 years, are now in equilibrium with the erosive forces of the river and gravity forces of the soil mass within the slide, and with piezometric pressures existing on failure surfaces (Hardy et al., 1978). Mining activities in both the Crownite and the Clayburn pits do not precipitate any noticeable instability.

Big Bend

The Big Bend area has the best natural exposures of the Crownite Formation. Because of steep slopes as a result of the Fraser River undercutting its western bank, the block sliding is advanced and individual blocks are relatively small in size. Some blocks sliding down the steep slope are only a few metres wide and a few tens to hundreds metres in length. Block sliding is active, as can be observed by bent and inclined trees and fresh slumps and scarps. This situation offers fresh (if somewhat hazardous) exposures of diatomite that are accessible for sampling. Samples were collected in two sections representing a 7.5 m thickness of diatomite beds. A volcanic ash layer was used as a marker to correlate beds in two separate blocks. Section 1 was sampled from the surface to the top of a 20 cm rusty, hard, dense volcanic ash layer 5 m from the top (Fig 2). In the second block, section 2 was sampled for 2.5 m below the volcanic marker bed (Fig 3). The marker was not sampled or analyzed. Analytical results are shown in Tables 1 and 2.

Crownite Pit

The Crownite pit has the largest exposure of diatomite beds in the Quesnel area. The pit was developed on Lot 906 at the western edge of the city over an area of approximately 300 by 600 m with four benches each 7 m high (Fig 4). The top bench was developed through diatomite up into an irregular layer of sandy gravel from 10 to 50 cm thick overlain by a basalt cap composed of up to 150 cm of pillow lava interspersed with palagonite breccia. In spite of extensive benching, fresh exposures of diatomite were rather uncommon due to 10 years of abandonment, sloughing and use of the pit by local all-terrain vehicles and dirt bikers. Therefore, the diatomite had to be sampled in five different segments to obtain a complete composite section. Tracing the

Figure 2. Site of Big Bend Section 1, Quesnel area.

marker horizon is difficult. It is probable that sampling of some parts of the section was duplicated, because of one or possibly two slump blocks between the top and bottom benches. Since the sampling followed the rainwater rills across the benches at approximately 45° dip, the 15 m of samples represent approximately 10 m of vertical thickness (Fig 5, Table 2).

Clayburn Pit

The Clayburn pit is located in the Buck Ridge area, Lot 1615, approximately 30 km south of Quesnel (Fig 1). The overburden has been stripped from this pit over an area of 100 by 100 m and two faces were exposed across the north and south part of the stripped area. The north face has exposed the diatomite bed over a thickness of 7 vertical metres (Fig 6). From the overall terrain configuration, it is estimated that the north face is below the marker bed. The marker bed is exposed in the southern face with diatomite for 3 m above and 2.5 m below it (Fig 7). In all Clayburn pit exposures, the diatomite beds exhibit features indicating slumping and displacement, such as bedding plane deformation, fractures filled with debris and soil, and an offset of the marker bed by approximately 1 vertical metre. A minor scarp along the western limits of Lot 1615, and displacement of basalt boulders, suggests the presence of a block slide plane. In the middle of the southern face, a shallow, 10 m wide depression in the Crownite Formation is infilled

Figure 3. Site of Big Bend Section 2, Quesnel area. A rusty-coloured bed in the upper left corner is the volcanic ash marker bed.

TABLE 1. CHEMICAL COMPOSITIONS OF BIG BEND SAMPLES, QUESNEL AREA, ANALYZED BY X-RAY FLUORESCENCE (XRF) FROM THE BONDAR AND CLEGG LABORATORY.

Lab No.	Field No.	SiO_2 (%)	TiO_2 (%)	Al_2O_3 (%)	Fe_2O_3* (%)	MnO (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	P_2O_5 (%)	LOI (%)	Total (%)	Ba (ppm)	Cr** (ppm)	
50366	BigBnd-1-0	69.48	0.41	11.74	4.29	0.03	1.06	0.58	0.36	0.88	0.05	10.53	99.47	495	94	**Section 1 0.0 5.0 m**
50367	BigBnd-1-0.5	70.94	0.4	10.93	3.97	0.02	1.06	0.5	0.33	0.87	0.05	10.24	99.37	466	107	
50368	BigBnd-1-1.0	70.46	0.5	10.45	3.94	0.05	0.97	0.48	0.29	0.75	0.05	10.67	98.66	399	79	
50369	BigBnd-1-1.5	65.41	0.41	12.15	4.35	0.03	1.02	0.59	0.33	0.8	0.05	14.35	99.54	438	105	
50370	BigBnd-1-2.0	68.72	0.58	10.76	3.79	0.05	0.94	0.51	0.28	0.81	0.05	12.04	98.58	417	73	
50372	BigBnd-1-2.5	66.92	0.53	11.55	4.75	0.13	1.02	0.54	0.32	0.91	0.07	12.18	98.97	463	87	
50373	BigBnd-1-3.0	58.68	0.34	9.96	11.58	0.6	1	0.61	0.26	0.79	0.13	16	100	433	72	
50374	BigBnd-1-3.5	65.98	0.52	11.39	3.73	0.03	1.02	0.47	0.39	0.87	0.06	14.62	99.13	447	83	
50375	BigBnd-1-4.0	62.09	0.5	13.32	4.37	0.03	1.06	0.62	0.33	0.89	0.06	15.84	99.16	454	89	
50376	BigBnd-1-4.5	38.63	0.35	7.3	29.2	1.07	0.34	0.74	0.65	1.92	0.28	18.29	98.81	393	-10	
50377	BigBnd-1-5.0	59.19	0.57	15.9	5	0.04	1.21	0.63	0.36	1.04	0.07	15.33	99.4	519	101	
50378	BigBbd-2-0.5	59.95	0.73	16.52	5.22	0.06	1.29	0.53	0.36	1.01	0.07	12.89	98.69	532	104	**Section 2 0.0 3.0 m**
50379	BigBnd-2-1.0	60.56	0.73	16.47	4.98	0.03	1.33	0.54	0.38	1.06	0.07	12.76	98.97	545	94	
50380	BigBnd-2-1.5	61.52	0.64	15.47	4.94	0.07	1.29	0.55	0.38	1	0.07	13.47	99.5	875	97	
50381	BigBnd-2-2.0	61.03	0.58	16.01	5.46	0.07	1.38	0.57	0.41	1.04	0.07	13.11	99.79	526	118	
50382	BigBnd-2-2.5	60.77	0.68	15.67	5.61	0.12	1.36	0.53	0.39	1.03	0.07	12.86	99.15	517	93	
50383	BigBnd-2-2.5	60.56	0.66	15.48	5.63	0.11	1.38	0.49	0.37	1.02	0.07	13.21	99.04	510	112	

TABLE 2. CHEMICAL COMPOSITIONS OF CROWNITE PIT SAMPLES, QUESNEL AREA, ANALYZED BY X-RAY FLUORESCENCE (XRF) FROM THE BONDAR AND CLEGG LABORATORY.

Lab. No.	Field No.	SiO_2 (%)	TiO_2 (%)	Al_2O_3 (%)	Fe_2O_3* (%)	MnO (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	P_2O_5 (%)	LOI (%)	Total (%)	Ba (ppm)	Cr** (ppm)	
50384	CR0-0.5	65.31	0.56	12.04	5.3	0.21	1.55	1.41	0.88	0.96	0.16	11.32	99.77	627	104	**Section 1 0.0 8.3 m**
50385	CR0.5-1.0	64.32	0.73	12.33	5.27	0.07	1.6	1.49	1.01	0.99	0.15	10.82	98.85	598	123	
50386	CR1.0-1.5	64.39	0.62	12.56	4.61	0.03	1.47	0.98	0.64	0.87	0.08	12.72	99.03	523	96	
50387	CR1.5-2.0	63.29	0.49	11.84	4.31	0.06	1.34	1.9	0.44	0.75	0.06	14.22	98.76	504	83	
50388	CR2.0-2.5	67.82	0.41	10.59	3.97	0.02	1.2	0.63	0.41	0.69	0.05	13.26	99.1	403	83	
50389	CR2.5-3.0	67.28	0.49	11.14	4.07	0.02	1.3	0.65	0.44	0.73	0.05	12.91	99.13	422	86	
50390	CR3.0-3.5	66.85	0.48	10.61	3.93	0.02	1.23	0.58	0.42	0.78	0.05	14.01	99.03	629	99	
50391	STD SY2	59.91	0.18	12.31	6.18	0.32	2.71	8.03	4.36	4.46	0.42	1.19	100.11	415	-10	
50392	CR3.5-4.0	68.37	0.41	11.3	4.12	0.02	1.33	0.58	0.44	0.85	0.05	12.56	100.09	460	90	
50393	CR4.0-4.5	66.87	0.42	10.69	4.16	0.02	1.29	0.57	0.39	0.81	0.05	13.07	98.41	573	133	
50394	CR4.5-5.0	69.09	0.42	10.47	4	0.02	1.25	0.6	0.42	0.76	0.05	11.86	98.99	442	81	
50395	CR5.0-5.5	67.47	0.4	10.55	4.06	0.03	1.23	0.59	0.43	0.79	0.05	12.89	98.55	484	79	
50396	CR5.5-5.95	68.48	0.37	10.37	3.9	0.06	1.18	0.53	0.35	0.71	0.04	12.79	98.83	399	85	
50397	CR5.95-6.3	68.43	0.35	9.99	3.84	0.03	1.14	0.51	0.35	0.72	0.04	13.44	98.89	396	145	
50398	CR6.3-7.0	66.97	0.41	10.79	4.16	0.05	1.26	0.58	0.43	0.83	0.05	13.17	98.75	437	110	
50399	CR7.0-7.6	67.64	0.4	10.51	4.09	0.02	1.14	0.6	0.44	0.81	0.04	12.99	98.74	485	116	
50400	CR7.6-7.8	68.13	0.39	9.1	7.32	0.02	0.87	0.46	0.35	1.26	0.06	10.99	99.05	855	127	
50401	CR7.67.8(DU)	67.96	0.42	9.39	7	0.02	0.91	0.47	0.38	1.19	0.06	11.24	99.15	980	112	
50402	CR7.8-8.3	68.58	0.41	10.19	3.86	0.02	1.15	0.68	0.47	0.78	0.05	12.86	99.11	468	148	
50403	CR2-0.0-0.3	65.12	0.41	11.53	5.85	0.15	1.33	0.8	0.41	0.86	0.1	12.38	99.2	2524	84	**Section 2 0.0 4.0 m**
50404	CR2-0.3-0.8	66.23	0.44	12.31	4.71	0.06	1.33	0.67	0.4	0.89	0.06	12.19	99.35	488	97	
50405	CR2-0.8-1.3	65.29	0.46	12.9	4.73	0.04	1.36	0.68	0.42	0.9	0.05	12.73	99.61	445	75	
50406	CR2-1.3-1.9	66.34	0.42	11.4	5.52	0.12	1.34	0.67	0.38	0.87	0.08	12.19	99.39	503	72	
50407	CR2-1.9-2.3	58.16	0.34	9.72	11.92	0.47	1.31	1.86	0.32	0.74	0.9	14.09	99.9	593	68	
50408	CR2-2.3-2.8	67.3	0.43	11.07	4.14	0.05	1.21	0.61	0.38	0.81	0.08	13.15	99.28	419	109	
50409	CR2-2.8-3.2	68.47	0.42	10.57	3.94	0.05	1.15	0.56	0.36	0.78	0.06	12.76	99.17	425	122	
50410	CR2-3.2-3.6	66.88	0.44	11.47	4.15	0.06	1.21	0.79	0.52	0.83	0.09	13.06	99.55	461	85	
50411	Std SY2	59.73	0.13	12.27	6.19	0.32	2.69	8.03	4.36	4.52	0.42	1.79	100.49	406	-10	
50412	CR2-3.6-4.0	66.6	0.4	11.37	4.35	0.05	1.26	0.65	0.38	0.86	0.12	13.22	99.31	436	82	
50413	CR3-0.0-0.5	68.38	0.46	10.76	3.95	0.02	1.13	0.62	0.37	0.8	0.04	12.51	99.09	401	88	**Section 3 0.0 8.0 m**
50414	CR3-0.5-1.2	67.53	0.47	10.49	3.89	0.02	1.08	0.62	0.34	0.75	0.04	13.86	99.14	405	76	
50415	CR3-1.2-1.5	71.95	0.44	8.54	2.94	0.01	0.89	0.55	0.28	0.7	0.05	12.51	98.92	488	103	
50416	CR3-1.5-2.0	71.41	0.41	8.5	3	0.01	0.88	0.57	0.28	0.58	0.04	13.06	98.78	321	72	
50417	CR3-2.0-2.5	70.25	0.36	9.96	3.78	0.02	1.01	0.69	0.39	0.7	0.04	12.32	99.57	373	107	
50418	CR3-2.5-3.O	70.08	0.44	9.34	3.33	0.02	0.97	0.57	0.31	0.67	0.04	12.87	98.7	559	76	
50419	CR3-3.0-3.5	70.11	0.48	9.46	3.35	0.02	0.99	0.6	0.33	0.67	0.04	12.5	98.6	421	73	
50420	CR3-3.5-4.0	70.68	0.48	9.21	3.18	0.03	0.95	0.59	0.3	0.65	0.04	12.53	98.69	447	78	
50421	CR33.5-4(DU)	71.04	0.47	9.38	3.3	0.03	0.98	0.61	0.33	0.66	0.04	12.07	98.99	671	105	
50422	CR3-4.0-4.5	71.48	0.33	9.01	3.33	0.06	0.94	0.63	0.35	0.64	0.04	12.64	99.49	378	71	
50423	CR3-4.5-5.0	70.22	0.46	9.58	3.38	0.03	0.98	0.61	0.36	0.67	0.04	12.51	98.89	399	94	
50424	CR3-5.0-5.5	69.73	0.49	9.82	3.54	0.05	1.03	0.67	0.47	0.73	0.05	12.17	98.82	588	71	
50425	CR3-5.5-6.0	65.88	0.48	11.14	3.91	0.21	1.16	0.66	0.47	0.9	0.06	12.84	-9	10000	73	
50426	CR3-6.0-6.5	65.87	0.48	12.08	4.58	0.1	1.27	0.65	0.44	0.94	0.05	12.76	99.27	459	77	
50427	CR3-6.5-7.0	51.75	0.35	8.87	19.04	0.35	1.27	1.1	0.3	0.68	0.43	15.55	99.79	905	57	
50428	CR3-7.0-7.2	53.57	0.39	9.2	16.75	0.26	1.31	1.11	0.31	0.71	0.43	15.45	99.54	405	56	
50429	CR3-7.2-8.0	65.3	0.59	12.34	4.56	0.07	1.23	0.68	0.41	0.89	0.06	12.8	98.98	450	83	
50430	CR4-0.0-0.4	73.53	0.24	6.71	4.56	0.07	0.87	0.38	0.28	0.56	0.06	11.93	99.23	287	75	**Section 4 0.0 4.3 m**
50431	STD SY2	59.46	0.28	12.25	6	0.31	2.66	7.97	4.36	4.44	0.42	1.12	99.31	409	12	
50432	CR4-0.4-0.9	68.48	0.3	7.29	4.04	0.14	0.85	4.29	0.43	0.67	2.54	10.79	99.9	682	78	
50433	CR4-0.9-1.5	73.41	0.4	8.13	3.31	0.03	0.98	0.6	0.37	0.7	0.12	11.01	99.11	441	91	
50434	CR4-1.5-2.0	72.28	0.39	8.62	3.41	0.02	1.09	0.46	0.34	0.7	0.04	11.84	99.24	387	76	
50435	CR4-2.0-2.5	72.37	0.39	8.38	3.32	0.02	1.05	0.44	0.33	0.66	0.04	11.94	98.99	392	74	
50436	CR4-2.5-3.0	73.13	0.31	8.24	3.38	0.05	1.05	0.45	0.33	0.68	0.04	11.97	99.67	330	111	
50437	CR4-3.0-3.5	70.64	0.36	9.54	3.75	0.06	1.2	0.53	0.42	0.77	0.04	12.45	99.82	511	82	
50438	CR4-3.5-4.0	71.62	0.36	8.94	3.59	0.06	1.08	0.5	0.34	0.65	0.04	12.26	99.49	376	78	
50439	CR4-4.5-4.3	74.3	0.3	7.41	2.88	0.06	0.9	0.43	0.32	0.56	0.03	12.31	99.54	302	66	
50440	CR5-0.0-0.3	46.95	0.31	8.63	24.74	0.34	1.25	0.88	0.31	0.71	0.38	15.54	100.1	539	89	**Section 5 0.0 4.5 m**
50441	CR50-0.3(DU)	47.05	0.3	8.61	25.64	0.45	1.23	0.9	0.32	0.71	0.4	15.11	100.78	552	70	
50442	CR5-0.3-0.8	66.34	0.46	12.12	4.92	0.04	1.27	0.6	0.42	0.91	0.07	12.6	99.81	506	131	
50443	CR5-0.8-1.1	67.16	0.49	11.79	4.34	0.04	1.24	0.6	0.43	0.89	0.06	12.63	99.73	523	99	
50444	CR5-1.1-1.6	52.68	0.38	9.42	19.03	0.35	1.2	0.74	0.37	0.76	0.25	15.01	100.25	523	59	
50445	CR5-1.6-1.9	65.66	0.46	11.79	5.17	0.06	1.27	0.59	0.38	0.89	0.07	13.13	99.55	750	81	
50446	CR5-1.9-2.1	53	0.35	9.48	18.44	0.31	1.18	0.72	0.36	0.78	0.25	15.37	100.3	529	59	
50447	CR5-2.1-2.5	65.01	0.45	12.13	5.11	0.18	1.25	0.75	0.52	1.01	0.07	13.3	99.89	1076	74	
50448	CR5-2.5-3.0	65.89	0.53	11.94	4.81	0.08	1.21	0.97	0.68	1.18	0.08	12.16	99.6	651	75	
50449	CR5-3.0-3.5	68.22	0.46	11.09	4.21	0.03	1.2	0.61	0.48	0.98	0.06	12.39	99.79	547	85	
50450	CR5-3.5-4.0	75.67	0.27	6.15	2.77	0.07	0.74	0.4	0.28	0.48	0.04	12.08	99	391	70	
50451	STD SO2	52.24	1.34	15.16	7.69	0.09	0.88	2.69	2.52	2.88	0.69	14.01	100.28	888	-10	
50452	CR5-4.0-4.5	75.65	0.24	6.33	2.84	0.2	0.74	0.4	0.27	0.52	0.04	11.67	98.94	340	66	

Figure 4. Crownite pit with the benches and section locations.

Figure 5. Exposing the bedrock for channel sampling.

Figure 6. Sampling the south face above the marker bed; Clayburn pit, Quesnel area.

Figure 7. Sampling the south face below the marker bed with 1 m vertical displacement; Clayburn pit, Quesnel area.

with 10 cm of silt, small pebbles, charcoal, diatomite fragments and up to 1 m of palagonite breccia interspersed with pillow basalt (Fig 9). Table 3 presents the analytical results.

Corral Scarp

About 5 km southeast of the Clayburn pit, an exposure of diatomite 15 m wide and 3 m high is located between the road to the Alexandria ferry and the Fraser River, next to a corral on the Lepetich farm. White, massive, blocky diatomite is exposed on a scarp/slump plane (Fig 10). Analysis of the sample taken from this outcrop (Table 4) indicates low clay contamination, comparable to some samples from the Clayburn pit.

DIATOMITE PRODUCTION AND END USES

In 2006, 799 000 tonnes of diatomite was produced from 11 separate mining areas and 9 processing facilities in the western United States (California, Nevada, Oregon and Washington). Of this tonnage, 59% is used for filtration, 22% is used as cement ingredient, 9% is for fillers, 5% for absorbents, 2% for insulation and 3% for a variety of other minor applications (Founie, 2007). Deposits in Nevada, Oregon and Washington are lacustrine in origin and are composed of diatoms like those of the Quesnel deposits.

Figure 8. Sampling the north face of the Clayburn pit, Quesnel area.

Figure 9. Basalt flow filling a shallow depression in Crownite Formation top; Clayburn pit, Quesnel area.

Diatomite from these deposits is processed into high-value end products.

Two samples of commercial diatomite — one from Nevada and the other from Oregon — have the following main components: the sample from Lovelock, Nevada has 89.75% SiO_2, 3.08% Al_2O_3, 1.33% Fe_2O_3 and an LOI of 4.70%. The sample from Vale, Oregon has 87.92% SiO_2, 3.66% Al_2O_3, 1.37% Fe_2O_3 and an LOI of 5.15% (Breese and Bodycomb, 2006).

According to Harben (1995), commercial diatomite contains from 85 to 94% SiO_2, from 1 to 7% Al_2O_3 and from 0.4 to 2.5% Fe_2O_3. Different end uses have a number of specific requirements in dry and wet density, sizing, median pore size, oil absorption and permeability.

TABLE 3. CHEMICAL COMPOSITION OF CLAYBURN PIT SAMPLES; ALL ELEMENTS ANALYZED BY X-RAY FLUORESCENCE (XRF) BY THE BONDOR AND CLEGG LABORATORY, EXCEPT FOR TOTAL S, WHICH WAS ANALYZED BY THE LECO INSTRUMENTS METHOD AT THE BONDAR AND CLEGG LABORATORY.

Lab. No.	Field No.	SiO_2 (%)	TiO_2 (%)	Al_2O_3 (%)	Fe_2O_3* (%)	MnO (%)	MgO (%)	Ba (ppm)	CaO (%)	Na_2O (%)	K_2O (%)	LOI (%)	Cr (%)	P_2O_5 (%)	Total (%)	S Tot (%)	
49059	Clay - M - Min - 0	70.48	0.41	8.4	2.69	0.03	0.89	295	0.35	0.43	0.49	14.46	64	0.03	98.7	0.38	**North face upper samples**
49060	Clay - M - Min - 0.5	71.39	0.38	7.62	2.34	0.04	0.83	309	0.29	0.44	0.45	14.22	41	-0.03	98.04	0.37	**0.0 3.5 m**
49061	Clay - M - Min - 0.5 (Rep.)	71.97	0.32	7.66	2.41	0.04	0.84	291	0.29	0.45	0.46	14.21	55	-0.03	98.69	0.38	
49062	Clay - M-Min - 1.0	72.18	0.37	7.18	2.45	0.01	0.87	276	0.26	0.43	0.44	14.03	41	-0.03	98.25	0.4	
49063	Clay - M-Min - 1.5	73.18	0.34	6.34	2.83	0.02	0.79	267	0.32	0.38	0.38	13.91	34	0.03	98.56	0.37	
49064	Clay - M-Min - 2.0	72.9	0.31	6.11	3.16	0.02	0.72	246	0.32	0.33	0.38	13.58	44	0.03	97.89	0.25	
49065	Clay - M-Min - 2.5	72.09	0.29	6.54	3.48	0.02	0.76	262	0.32	0.33	0.39	13.89	37	0.03	98.17	0.25	
49066	Clay - M-Min - 3.0	70.89	0.3	6.81	3.75	0.04	0.87	265	0.41	0.4	0.42	14.38	41	0.04	98.34	0.41	
49067	Clay - M-Min - 3.5	71.2	0.31	6.42	3.93	0.04	0.84	267	0.31	0.35	0.39	14.64	34	0.04	98.49	0.35	
49068	Clay - M - Plus - 0	67.02	0.5	10.88	3.02	0.03	0.83	333	0.38	0.34	0.55	14.58	58	0.03	98.2	0.13	**North face lower samples**
49069	Clay - M-Min - 0.5	66.84	0.53	11.43	3.21	0.02	0.94	381	0.45	0.36	0.59	14.35	70	0.04	98.81	0.21	**0.0 3.5 m**
49070	Clay - M-Min - 1.0	64.92	0.51	10.72	3.74	0.03	1.15	358	0.65	0.54	0.56	15.58	58	0.04	98.49	0.58	
49071	Std. SO 2	51.83	1.29	14.69	7.4	0.09	0.81	851	2.6	2.37	2.77	14.43	30	0.66	99.02	0.03	
49072	Clay - M-Min - 1.5	63.81	0.54	10.74	4.3	0.03	1.17	392	0.76	0.53	0.57	15.81	62	0.05	98.36	0.58	
49073	Clay - M-Min - 2.0	64.09	0.53	10.38	3.35	0.03	1.24	366	0.8	0.53	0.54	15.89	64	0.04	97.46	0.72	
49074	Clay - M-Min - 2.5	66.01	0.51	10.59	2.97	0.02	1.07	384	0.46	0.46	0.55	15.4	70	0.04	98.13	0.35	
49075	Clay - M-Min - 3.0	65.15	0.52	10.64	2.97	0.02	1.18	311	0.72	0.47	0.52	15.7	57	-0.03	97.92	0.64	
49076	Clay - M-Min - 3.5	63.39	0.47	10.61	4.17	0.02	1.25	308	0.97	0.43	0.48	16.03	58	-0.03	97.86	0.63	
49077	Clay Top 1	65.5	0.41	10.03	4.69	0.04	1.26	386	0.82	0.42	0.58	14.6	64	0.04	98.44	0.24	**South face upper samples**
49078	Clay Top 2	64.32	0.44	8.9	6.39	0.1	1.58	379	0.94	0.5	0.53	14.91	61	0.05	98.7	0.34	**0.0 3.0 m**
49079	Clay Top 3	69.09	0.42	7.84	3.89	0.05	1.3	333	0.67	0.58	0.5	13.99	60	0.04	98.41	0.35	
49080	Clay Top 4	69.07	0.52	9.57	3.71	0.03	0.93	567	0.76	0.79	0.94	12.44	54	0.05	98.88	0.11	
49081	Clay Top 4 (Rep.)	68.89	0.5	9.64	3.74	0.03	0.95	538	0.75	0.79	0.95	12.45	47	0.05	98.8	0.11	
49082	Clay Top 5	71.83	0.42	7.79	2.68	0.01	0.85	371	0.38	0.39	0.55	13.31	53	0.04	98.29	0.08	
49083	Clay Top 6	75.84	0.25	6.07	2.14	0.01	0.68	303	0.36	0.37	0.42	12.84	45	0.03	99.04	0.11	
49084	Clay Low -1	73.24	0.36	7.08	2.35	0.01	0.79	319	0.36	0.35	0.43	13.24	49	0.03	98.27	0.14	**South face lower samples**
49085	Clay Low -2	75.35	0.31	6.37	2.18	0.04	0.64	285	0.27	0.25	0.37	12.8	49	-0.03	98.61	0.02	**0.0 2.5 m**
49086	Clay Low -3	76.56	0.24	5.49	2.01	0.02	0.55	252	0.25	0.22	0.33	12.66	46	-0.03	98.36	0.02	
49087	Clay Low -4	76.42	0.29	5.12	1.96	0.02	0.58	239	0.52	0.27	0.33	12.56	36	-0.03	98.1	0.04	
49088	Clay Low -5	76.51	0.31	5.31	1.91	0.02	0.55	241	0.39	0.23	0.33	12.56	44	-0.03	98.15	0.04	

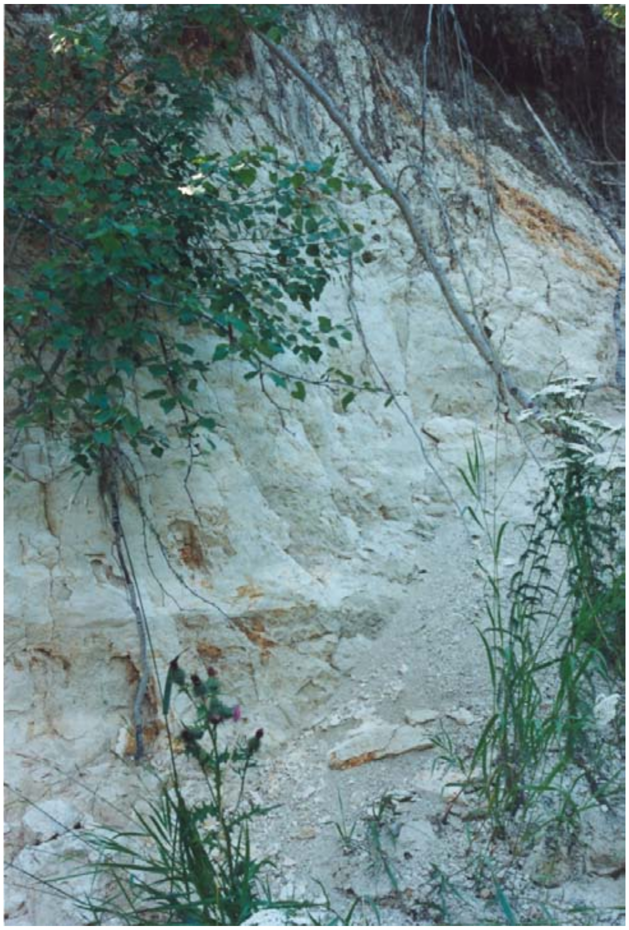

Figure 10. Corral scarp outcrop, Lepetich farm, showing white, massive, blocky diatomite exposed on a scarp/slump plane.

CONCLUSIONS

Proven production records indicate that Quesnel diatomite is suitable for end uses having low purity requirements, such as insulation bricks, pozzolan admixtures and domestic and industrial absorbents. Attempts to develop higher-end value products in the past have not succeeded. It should be mentioned here, though, that the major industry development of lacustrine diatomite deposits in the western United States has taken place in the last 20 to 30 years and was preceded by extensive processing studies by United States Bureau of Mines. There have also been processes developed for the beneficiation of Quesnel diatomite, which reduced the Al_2O_3 content from 12.38 to 4.8% in the intermediate product fraction (Visman and Picard, 1969). Main components of Quesnel diatomite are also not very different from those published for raw product from commercial deposits.

Comparing analytical results from three main sampled sites in our study, there is an apparent decrease in Al_2O_3 content from north to south. A significant number of samples from the Clayburn pit have Al_2O_3 values between 5 and 8 %, compared to a few samples from the Crownite pit and only two from the Big Bend. Therefore, the areas of Buck Ridge and the Alexandria ferry probably have the best potential for diatomite with the lowest content of impurities and future industrial development.

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TABLE 4. CHEMICAL COMPOSITION OF LEPETICH FARM CORRAL SAMPLE; ALL ELEMENTS ANALYZED BY X-RAY FLUORESCENCE (XRF) BY THE BONDAR AND CLEGG LABORATORY.

Lab. No.	Field No.	SiO_2 (%)	TiO_2 (%)	Al_2O_3 (%)	Fe_2O_3* (%)	MnO (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	P_2O_5 (%)	LOI (%)	Total (%)	Ba (ppm)	Cr** (ppm)
50359	Lep-corral	78.6	0.31	6.01	2.09	0.01	0.63	0.24	0.59	0.4	0.11	9.55	98.58	285	112

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