BRITISH COLUMBIA DEPARTMENT OF MINES

HON. JOHN H. CATES, *Minister* JOHN F. WALKER, *Deputy Minister*

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Clay and Shale Deposits
of British Columbia

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GENERAL STATEMENT

This report is a review of information on clay and shale deposits in British Columbia and is based on field examinations by the writers and on published data from several sources. Since, in general, clays are of low unit value and cannot be transported profitably for long distances, attention is restricted to deposits in populous areas, except for a few occurrences of higher-quality clay close to rail.

For present purposes the term " clay " includes shales of ceramic value as well as true clays. With a few exceptions, the latter are Pleistocene or Recent in age, are of sedimentary origin, and, although widely distributed throughout the Province, have the common characteristics of low fusion temperature, short vitrification range, salmon to red firing colours, and usefulness restricted to the manufacture of building products and earthenware pottery. On the other hand, the shales covered in this report show much greater diversity, ranging from Cambrian to Tertiary in age and being variously suitable for refractories, whitewares, and pottery, as well as building products.

The locations of clay deposits on which specific information is available are shown on the accompanying key map, and pertinent data are presented in tabular form. The clay resources of the more thickly populated areas of the Province are also discussed. The refractory shales of Sumas and Blue Mountains near Abbotsford and Whonnock, the Giscome Rapids china-clay deposit on the Fraser River, 20 miles north of Prince George, and bentonite occurrences in the Princeton-Merritt area are the only deposits described individually.

All the known Recent or Pleistocene deposits of clay and all Cretaceous shales in the Province are red burning and suitable only for the manufacture of common structural products, except for a few that are suitable for making low-grade pottery such as flowerpots. Common clay products are heavy, of low unit value, and cannot profitably be transported far to markets. The commercial exploitation of the red-burning clays and shales of British Columbia is therefore controlled basically by proximity to the markets afforded by populated areas. In other words, although deposits are widely distributed throughout the Province, there is promise for sustained and profitable operations only for those that are close to markets. This is demonstrated by the fact that of the more than seventy known brick plants which have worked at various times and various places in British Columbia only ten are producing at present, and all of these are close to Vancouver or Victoria.

To a lesser degree the above discussion applies to all clay deposits, with the reservation that good-quality china-clay, fireclay, and stoneware clay are not common and hence have higher unit value. These materials or their products may thus be transported profitably for considerable distances, but their value is still low and deposits must be situated close to rail or tidewater to have commercial possibilities. In British Columbia workable deposits of all three of the above types occur, but, with the exception of the fireclays of Sumas Mountain, are as yet undeveloped. All known occurrences of high-quality clays and shales in the Province are Tertiary in age, and it is to formations of this period that attention should be directed for further prospecting.

Brief notes on the known occurrences in British Columbia of miscellaneous ceramic materials other than clay are included in this report as Chapter VII.

THE HISTORY OF CLAY WORKING IN BRITISH COLUMBIA*

It was not until 1905 that the Annual Report of the Minister of Mines began to show production figures, although scattered references to clay manufacture are made in reports previous to this date. The following historical notes are based on excerpts from the press at the time and on references in the Annual Reports of the Minister of Mines.

It is on record in the Melrose Diary that a kiln of bricks was burned off on August 23rd, 1853, at Craigflower. Commercial production, however, would appear to date from 1859, when, in the British Columbia Gazette, a Mr. Porter in Victoria began advertising bricks for sale. In the New Westminster British Columbian of August 1st, 1861, it is reported from Yale that the first kiln of bricks was burned there. These bricks were to compete with products from Victoria and New Westminster, so evidently there had been production in the latter place also, although, except for a short note indicating an unsuccessful attempt at manufacture in 1859, specific data are lacking. The site now occupied by Marpole next comes into the picture, where in March, 1862, a Mr. McRoberts started to build a plant. In July, 1865, the second brickyard in New Westminster was built by McGregor and Company.

The Victoria Colonist of September 8th, 1878, describes an explosion in the Humber Brickyard on Saanich Road. A July, 1884, issue of the same paper states that a yard was being built in New Westminster to provide bricks for the asylum. A year later the Colonist mentions financial difficulties of the Victoria yard of Kempters.

In 1886 a kiln producing 67,000 bricks was burned near the Big Slide mine to build the furnaces for the mine plant on Pavilion Mountain just north of Lillooet. Two years later, near Barkerville in the Cariboo, 80,000 bricks " of good quality " were turned out for construction of the Government Reduction Works.

In 1890 British Columbia Pottery and Terra Cotta Company commenced operation in Victoria West and made various products from a combination of local glacial clay, the so-called " fireclay " (actually cone 8 material) from the Wellington and Union Collieries, and pyrophyllite from Kyuquot. Two of the early commissions of this plant were to supply firebricks for ships of the British Navy on the Pacific Coast and to provide bricks to build coke-ovens at the Union Collieries, north of Nanaimo. The company operated more or less continuously until 1918 and was finally dissolved in 1929. A résumé of the Victoria brick industry in the January 1st, 1893, Victoria Colonist gives production figures for the following yards: Baker Brothers, Smith & Elford, Humber, Coughlan & Mason, and Jennings Brothers.

Records mention a Port Haney Brick, Tile and Terra Cotta Company Limited in 1891, but nothing further is reported on this company.

During 1892 there was talk of the establishment of a pottery and firebrick plant near Nanaimo or Wellington to use the previously mentioned " fireclay " from the local mines. Just when plants in this district were actually begun is not on record, but it is known that in 1899 there were two brick-kilns of 40,000 capacity each in operation at the Alexandria Colliery, Union Bay. Common brick and firebrick were made from surface clay and clay from the Union Collieries. Brick production is recorded from Comox for 1901 and 1902, but whether or not this was from the Alexandria Colliery kilns is not indicated.

In 1897 at least two new plants went into operation. On Anvil Island, near the head of Howe Sound, Columbia Clay Company opened a plant that was rated the largest in the Province by 1905 and continued to produce until some time after 1912. Fernie Brick Company Limited also was established in 1897 and until about 1901 produced common cream-coloured brick for local use.

West Kootenay Brick and Lime Company Limited began operating at Nelson in 1899 but is not mentioned in later records.

* In this account most of the information on the earlier activities was supplied by W. Ireland, Provincial Archivist; the remainder is from Department of Mines records.

Since 1900, records are more complete but still lack many details. At Victoria, Elford & Smith's yard became known as Victoria Brick Company Limited in 1912. Operations continued here until 1929, when production seems to have ceased. The property was later taken over by and is now part of the Baker Brick and Tile yards. The yard of Baker Brothers, later Baker Brick and Tile Company, was in operation before 1893 and is the only yard producing brick and tile in Victoria to-day. The Humber Brickyard, mentioned before, was still in operation in 1922 on property adjoining that of the Victoria Brick Company. Another yard, Pioneer Brick Company, existed between 1919 and 1923, but nothing else is known of it.

Bricks were produced in Sidney by Sydney Brick and Tile Company in 1910. No further information is at hand on this company. In 1911 Bazan Bay Brick and Tile Company was in operation; whether or not it took over the Sydney Brick and Tile Company property is not known. The Bazan Bay Company has continued to operate more or less continuously to date, except for the year 1925, when the plant was leased to North Saanich Brick and Tile Company.

In 1908 a group of Chinese were making red brick by hand from glacial clay near Somenos. In the same locality Jennings and Son opened a plant in 1911 and were still operating in 1932.

In addition to the previously mentioned brick plants of the Nanaimo district, at least four other companies made brick there. Nanaimo Pressed Brick and Terra Cotta Limited operated at East Wellington between 1910 and 1923. In 1927 mention is made of Nanaimo Pressed Brick and Tile Company at the same place, this may be a new name for the last-mentioned company. East Wellington Pressed Brick and Tile Company Limited functioned during 1911 but is not reported later. Mountain District Brick and Tile Company of East Wellington, in production from 1912 to 1915, was dissolved, restored in 1928, and finally dissolved again in 1946.

Several of the Gulf Islands have had brick plants in the past, but only the plant on Gabriola Island has survived until to-day. On Sidney Island a yard opened in 1907 and is known to have produced brick from 1913 to 1918. This may refer to Sidney Island Brick and Tile Company that was in operation in 1912 and continued to operate until 1917, being dissolved in 1924. From 1926 to 1929 Peerless Brick and Tile Company was working somewhere on Sidney Island. Mayne Island had its Mayne Island Brick Company organized in 1913, but it never operated. In 1912 Coast Shale Brick Company opened up on Pender Island; it apparently closed the same year but is reported to have operated in 1916. Shale Products Company is mentioned as operating on this same island in 1913, this may be a mistaken name for the previously mentioned company. In 1916 Tyee Shale Products Company also worked for a while on Pender Island. Gabriola Island was the home of Dominion Shale, Brick, and Sewer Pipe Company Limited for the period from 1911 to 1928. A second producer on Gabriola Island was Dominion Shale Products Company Limited. This latter company changed its name in 1918 to Gabriola Shale Products Limited and operated until 1940, when it changed hands and became T. A. McBride Company. During 1942 Evans, Coleman & Evans Limited took over the plant and have operated it until now under its former name, Gabriola Shale Products Limited.

There were two brickyards on Anvil Island. Columbia Clay Company, mentioned before, began operations in 1897 and was still operating in 1912, after which it is not mentioned. Anvil Island Brick Company worked during the years from 1910 to 1917. 926-43

On the Mainland at Sechelt a plant operated for some time before 1910, when it closed. It is thought there were bricks made at one time at Pender Harbour.

Apparently Vancouver has never had a large brickyard. Early references give names only, and it is possible some are of distributers and not manufacturers. In 1909 Pacific Pressed Brick Company is mentioned, and in 1910 Red Cliff Brick and Tile Company; in 1911 Pacific Coast Brick and Tile Company was organized but did nothing, and in the same year Vancouver Pressed Brick and Stone Limited is noted; in 1913 Taylor Brick

Company was registered; during 1922 Ceramics Industries Limited made bricks on Granville Island from Anvil Island clay; and 1929 marks the end of Western Brick and Tile Company Limited. A small concern began making firebrick, special shapes, and blocks in 1926 under the name of B.C. Refractories. This company has continued operations to date, more recently under the name of Fairey & Company Limited. Atlas Clay Products Limited, in existence from 1927 to 1946, had property on Sumas Mountain but has no record of production. A small flower-pot factory, B.C. Clay Products Limited, has been active from 1932 to date. Firebrick and specialty shapes and products have been made by Richmix Company since about 1937.

In New Westminster the yard of John Coughlan and Sons operated in 1908 and from 1911 to 1915. A second yard, Pacific Brick Company, produced from 1929 to 1933 and was dissolved as a company in 1937. One other company, Fraser River Brick Company, 2 miles southwest of the city, was operating in 1911 but closed permanently in 1914.

Two companies have worked at Cloverdale, but each for a year only. These were Cloverdale Brick and Tile in 1913 and Mainland Tile in 1931. At near-by Sullivan, Vancouver Brick and Tile Company was in production from 1927 to 1944.

The second largest clay-works in British Columbia opened in 1907 at Port Haney as Port Haney Brick Company Limited. It has remained in production to date, lately specializing in the manufacture of agricultural drain-tile.

Ruskin was the scene of two attempts at clay manufacture. In 1912 Heaps Brick Company made an experimental batch of brick for its own use but closed the next year without marketing any brick. In the same year Gilchrest Brick and Development Company organized but apparently did nothing more.

The shale deposits of Sumas Mountain, just east of Abbotsford, have been used continuously since 1905. First development was the opening of the Vancouver Fire Clay Company works at Clayburn in 1905. In 1910 Clayburn Company Limited was organized and bought out Vancouver Fire Clay Company, and in 1918 they also bought a plant at Kilgard, on the south side of Sumas Mountain. The Clayburn Company closed the plant at Clayburn in 1930 and consolidated its works at the Kilgard site. After a fire destroyed part of the Kilgard factory in 1949, the present plants at Kilgard and Abbotsford were constructed. In 1910, at Kilgard, Kilgard Fireclay Company took over the Vancouver Sewer Pipe and Refractory Company holdings and operated until 1939, when Sumas Firebrick Company took over. Sumas Firebrick Company maintained a plant in New Westminster and a quarry at Kilgard.

Most of the towns of the Interior have had a brick-works at some time or other in their history. Kamloops had Johnston and Sons between 1910 and 1926; there was reported to have been one in Merritt; in Enderby there was Enderby Brick and Tile from 1910 to 1926, followed by Percy Gorse from 1926 to 1941; Armstrong had its Armstrong Brick Works in 1916 and 1917, and later some hand-made bricks were produced in 1923, 1924, and 1926; Lakeside Clay Products opened up at Okanagan Landing in 1920 but had closed by 1924; and in Kelowna, William Haug and Sons were active from before 1932 until 1940.

Northern Brick and Tile Company was organized in Prince Rupert in 1913 but never operated; at Terrace a brick company did experimental work in 1931 but never went into commercial production; Smithers was the scene of a small brick-making operation between 1928 and 1931; a yard at Prince George operated from 1930 to 1933; and for a short time bricks were made at Quesnel.

In the eastern part of the Province the Doukhobors were active in the brick industry around Grand Forks from 1905 to 1934, at Brilliant, and at Castlegar. A yard at Nelson worked in 1910 but shut down in 1917 because of lack of sales; Hanson's Brick Yard operated in Cranbrook from 1912 to 1914; there is supposed to have been brick made at Kimberley at one time; and common brick was manufactured near Windermere in 1911.

During the last ten years several new brickyards and small pottery plants have begun. In 1946, near Abbotsford, Abbotsford Fire and Pressed Brick Company began operations.

This plant, active off and on to date, is now operated as Fraser Valley Brick Company Limited. The year 1947 was the opening date for several works: Cowichan Metallic Brick Company, near Duncan, not operating now; Ravine Potteries in Vancouver, not heard from since; Lambert Potteries, still operating; Mainland Clay Products Limited at Barnet, still operating after changing management several times; Pacific Clay Products Limited at Pleasantside, near Port Moody, closed in 1950; Bear Creek Brick Yard in Surrey, still operating; Falkland Brick, Tile, and Pottery Company at Falkland, opened and closed the same year; Love's yard in Grand Forks, closed the next year. In 1949 Burrard Brick Company built a kiln in the same yard as Pacific Clay Products at Pleasantside but never produced any bricks. In Vancouver at present Importex Company and Crown Ceramics manufacture art pottery on a small scale as does A. Ebring at Vernon.

THE CLAY PRODUCTS INDUSTRY IN BRITISH COLUMBIA

There are at present twelve plants in British Columbia (*see* Table I) manufacturing common structural clay products from local materials. The products made are wire-cut and dry-press red brick, drain-tile, building-tile, flue-lining, and flower-pots. Apart from one operation using a coal-fired Hoffman chamber kiln and two others using wood-fired scove kilns, remaining production is made in a total of fourteen down-draught kilns—one fired by oil, seven by wood, and six by coal. Other clay-products operations in the Province utilizing local materials are those of Clayburn Company Limited, with a firebrick plant at Abbotsford and a sewer-pipe plant at Kilgard. The former makes dry-press common and high heat duty firebrick and shapes as well as facebrick in an oil-fired tunnel kiln; the latter makes sewer-pipe and flue-lining in six oil-fired down-draught kilns. In addition, Richmix Clays Limited produces firebrick and facebrick in a coal-fired down-draught kiln in Vancouver.

Production of clay products in British Columbia for 1948, 1949, and 1950 is tabulated below.

	Quantity			Value		
	1948	1949	1950	1948	1949	1950
Brick—	No.	No.	No.	$	$	$
Common	*3,810,000*	*3,220,000*	*3,910,500*	*111,300*	*95,075*	*103,840*
Face, paving, sewer	2,584,752	509,560	1,974,380	129,268	24,793	54,503
Firebricks, blocks	......	......	......	392,458	135,391	254,262
Clays	......	......	......	32,922	22,339	32,264
Structural tile—hollow blocks	......	......	......	116,513	145,512	191,016
Drain-tile, sewer-pipe, flue-linings	......	......	......	597,541	265,098	428,418
Pottery—glazed or unglazed	......	......	......	5,138	5,176	5,860
Other clay products	......	......	......	9,611	9,676	11,335
Totals	......	......	......	*1,394,751*	*703,060*	*1,081,498*

Pertinent data on clay plants no longer operating in the Province are given in Table II. It will be noted that at least fifteen of them were simple hand-moulding operations to supply restricted local demands as required. The remainder were of a more permanent nature, for the most part situated in the Lower Mainland or on Vancouver Island, and producing dry-press or wire-cut red brick and tile, with the exception of the Clayburn and B.C. Pottery operations, which made firebrick as well.

Total yearly values of past production of clay and clay products in British Columbia are given below:—

Year	Value	Year	Value
1911	$725,336	1940	$519,583
1920	622,270	1950	1,081,498
1930	690,571		

Statistics for the years previous to 1911 are incomplete, and the values of clay products were not kept separate from those for other building materials. The greatest production for any year to date was that for 1948, as shown in the previous table.

TABLE I.—ACTIVE CLAY-WORKING PLANTS OF BRITISH COLUMBIA

Map No.	Name	Location	Source of Clay	Products Made	Description of Plant	References
16	Evans, Coleman & Evans Limited	Gabriola Island — 5 miles by road southeast of the ferry landing	Cretaceous shale from pits adjacent to plant	Common brick	Dry-press, coal-fired semi-continuous Hoffman chamber kilns	B.C.M.M. 1947, p. 207. G.S.C. Mem. 65, 1915, p. 17; Mem. 47, 1914, p. 57.
24	Bazan Bay Brick & Tile Company Limited	Saanichton	Local surface clay	Common brick and drain-tile	Stiff-mud, one oil-fired down-draught kiln	B.C.M.M. 1947, p. 205.
28	Baker Brick & Tile Company Limited	Victoria	Local surface clay	Building-tile, interlocking tile, drain-tile, and flower-pots	Stiff-mud, three down-draught wood-fired kilns	G.S.C. Mem. 24E, 1912, p. 149. B.C.M.M. 1908, p. 182; 1947, p. 205.
35	B.C. Clay Products Limited	Vancouver	Local surface clay	Flower-pots		B.C.M.M. 1947, p. 205.
36	Fairey and Company Limited	Vancouver	Various local and imported clays and shales	Refractory shapes and specialties		B.C.M.M. 1947, p. 206.
37	Richmix Clays Limited	Vancouver	Tertiary shales frrom Kilgard	Firebrick, facebrick, and fireclay	Dry-press and stiff-mud, one coal-fired down-draught kiln	B.C.M.M. 1947, p. 207.
39	Mainland Clay Products Limited	Barnet	Tertiary shale from Kilgard and surface clay	Common brick	Dry-press and stiff-mud, wood- and coal-fired scove kilns	B.C.M.M. 1947, p. 207.
47	Victoria Tile & Brick Supply Co. Ltd. (Bear Creek Brick Company)	Surrey	Local surface clay	Common brick	Soft-mud, wood-fired scove kilns	B.C.M.M. 1947, p. 205.
50	Port Haney Brick Company *Limited*	Haney	Local surface clay	Building-tile, drain-tile, and flue-lining	Stiff-mud, wood- and coal-fired down-draught kilns	G.S.C. Mem. 24E, 1912, p. 141. B.C.M.M. 1908, p. 186; 1947, p. 207.
57	Fraser Valley Brick Company Limited (plant formerly operated by Abbotsford Fire & Pressed Brick Co. Ltd.)	Abbotsford—1 mile east of town	Tertiary shale from Sumas Mountain, 1 mile east of plant	Common brick	Dry-press, wood- and coal-fired up-draught kilns	B.C.M.M. 1947, p. 205.
58	Clayburn Company Limited	Abbotsford	Tertiary shales from Kilgard on Sumas Mountain	Refractory and facebrick	Dry-press, continuous oil-fired tunnel kiln	*See* this report, p. 25.
59	Clayburn Company Limited	Kilgard	Tertiary shales from Sumas Mountain	Sewer-pipe and flue-lining	Stiff-mud, coal- and oil-fired down-draught kilns	G.S.C. Mem. 24E, 1912, pp. 131, 136; Mem. 65, 1915, p. 15. B.C.M.M. 1947, pp. 205, 206. *See* this report, p. 25.

TABLE II.—INACTIVE CLAY-WORKING PLANTS OF BRITISH COLUMBIA

Map No.	Name	Location	Source of Clay	Products Made	Description of Plant	References
9	Wellington Colliery Company Limited	Union Bay	Cretaceous shale from coal mine	Firebrick and blocks	Shut down about 1905	B.C.M.M. 1908, p. 185.
15	Mountain Brick & Tile Company	East Wellington — 4 miles from Nanaimo	Cretaceous shale	Brick	Stiff-mud, scove kilns	G.S.C. Mem. 47, 1914, p. 59.
17		Millstone River	Surface clay	Brick	Soft-mud, hand-moulded	B.C.M.M. 1908, p. 185. G.S.C. Mem. 51, 1914, p. 121.
18		Boulder Point—southeast of Ladysmith	Surface clay	*Brick*	*Soft-mud, hand-moulded*	G.S.C. Mem. 96, 1917, p. 397.
19	Jennings and Son	Somenos		Common red brick		
20	Chinese Yard	Somenos—8 miles north of Duncan on E. & N. Railway	Surface clay	Brick	Soft-mud, hand-moulded	B.C.M.M. 1908, p. 185.
21	Mayne Island Shale Brick Company Limited	Mayne Island	Cretaceous shale	Brick		
22	Coast Shale Brick Company Limited	Pender Island	Cretaceous shale	Brick	Stiff-mud, oil-fired scove kilns	G.S.C. Mem. 47, 1914, p. 59.
23	Cowichan Metallic Brick Co.	Hillbank—half a mile west of station	Local cretaceous shale	Brick	Dry-press, wood-fired scove kilns	B.C.M.M. 1947, p. 206.
24	North Saanich Brick and Tile Company Limited	Sidney	Surface clay	Brick		
24	Sydney Brick & Tile Co.	Sidney	Surface clay	Brick		G.S.C. Mem. 24E, 1912, p. 145.
25		Sidney Island	Surface clay	Brick	Stiff-mud	G.S.C. Mem. 24E, 1912, p. 143; Mem. 36, 1913, p. 109.
28	British Columbia Pottery Company Limited	Victoria	Various clays and shales	Sewer-pipe, etc.		B.C.M.M. 1908, p. 185. G.S.C. Mem. 24E, 1912, p. 143.
28	The Victoria Brick Company Limited	Victoria	Surface clay	*Brick*	Now associated with Baker Brick & Tile Company Limited	
28	Humber Brick Co.	Victoria				B.C.M.M. 1908, p. 184.
31	Anvil Island Brick Company Limited	Anvil Island	Surface clay	Brick	Dry-press, down-draught kiln	G.S.C. Mem. 24E, 1912, p. 142.
31	The Columbia Clay Co. Limited	Anvil Island	Surface clay	Brick	Soft-mud, continuous kilns, *chamber type*	G.S.C. Mem. 24E, 1912, p. 142. B.C.M.M. 1908, p. 186.
35A	B.C. Refractories Limited	Vancouver	Various sources	Refractory specialties		
	Vancouver Clay Products Limited	Vancouver	Surface clay			
40	Pacific Clay Products Limited (Coast Clay Products)	Pleasantside	Local surface clay	Common and facebrick	Stiff-mud, wood-fired down-draught kiln	B.C.M.M. 1947, p. 207.
41	Burrard Brick & Tile Company	Pleasantside	Local surface clay	Common brick		B.C.M.M. 1947, p. 205.
43	Coughlan and Sons Company	New Westminster	Surface clay	Brick and drain-tile	Soft-mud, continuous kiln, chamber type	G.S.C. Mem. 24E, 1912, p. 140. B.C.M.M. 1908, p. 185.
44	Pacific Brick Limited	New Westminster		Red brick		
45	Fraser River Brick and Tile Co. Limited	South side Fraser River, 2 miles from *New Westminster*	Surface clay	Brick	Stiff-mud	G.S.C. Mem. 24E, 1912, p. 140.

TABLE II.—INACTIVE CLAY-WORKING PLANTS OF BRITISH COLUMBIA—*Continued*

Map No.	Name	Location	Source of Clay	Products Made	Description of Plant	References
48	Vancouver Brick and Tile Company	Sullivan	Surface clay	Common brick		
49	Mainland Tile & Brick Co. (Surrey Brick and Tile Company Limited)	Cloverdale — 1 mile north of town	Surface clay	Drain-tile and common brick		
52	Heaps Brick Company Limited	Ruskin	Surface clay	Common brick and drain-tile	Stiff-mud and dry-press, continuous chamber kiln	G.S.C. Mem. 47, 1914, p. 54.
56	Clayburn Company Limited	Clayburn	Tertiary shale from Sumas Mountain	Sewer-pipe, refractories, facebrick, etc.	Stiff-mud	G.S.C. Mem. 25, 1913, p. 76; Mem. 24E, 1912, pp. 126, 131. B.C.M.M. 1908, p. 186; 1926, p. 326.
64	Johnston and Company Limited	Kamloops	Surface clay	Common brick	Dry-press	G.S.C. Mem. 24E, 1912, p. 120.
67	Falkland Brick, Tile & Pottery Limited	Falkland	Surface clay from Westwold (65) and 11 miles north on Pillar Lake Road (66)	Common brick	Stiff-mud, wood-fired scove kilns	B.C.M.M. 1947, p. 206.
68	Enderby Brick Company Limited	Enderby	Local surface clay	Common brick and drain-tile	Stiff-mud and dry-press, down-draught kilns	G.S.C. Sum. Rept. 1931, Pt. A, p. 99A. G.S.C. Mem. 24E, 1912, p. 118.
69	The Lakeside Clay Products Limited	Okanagan Landing	Local surface clay	Brick and tile		G.S.C. Sum. Rept. 1931, Pt. A, p. 99A.
70		Vernon	Local surface clay	Common brick		G.S.C. Sum. Rept. 1931, Pt. A, p. 99A.
71	Haug and Son	Kelowna	Local surface clay	Common brick		
73		Merritt	Local surface clay	Common brick		
77		Princeton	Local shale	Common brick		G.S.C. Mem. 65, 1915, p. 21.
81	T. A. Love Bricks Ltd.	Grand Forks—3 miles west of plant (80)	Surface clay	Common brick	Soft-mud, oil-fired scove kilns	B.C.M.M. 1947, p. 207.
83		Castlegar	Local surface clay	Common brick		G.S.C. Mem. 24E, 1912, p. 118.
84		Nelson	Local surface clay	Common brick		G.S.C. Mem. 24E, 1912, p. 118.
87	Hanson Yard	Cranbrook	Local surface clay	Common brick and drain-tile		G.S.C. Mem. 65, 1915, p. 33.
94		Fernie	Local surface clay	Common brick		G.S.C. Mem. 25, 1913, p. 67.
96		Windermere	Local surface clay	Common brick		G.S.C. Mem. 25, 1913, p. 69.
104		Quesnel	Local tertiary clay	Common brick	Soft-mud, hand-moulded	G.S.C. Mem. 118, 1920, p. 71.
108	Prince George Brick Co.	Prince George	Local surface clay	Common brick		
116		Fort Fraser	Local surface clay	Common brick		
117	Smithers Brick Co.	Smithers	Local surface clay	Common brick	Hand-moulded	
118	Terrace Brick Co.	Terrace	Local surface clay	Common brick		

CHAPTER II.—CLAY AND SHALE DEPOSITS IN BRITISH COLUMBIA

GENERAL STATEMENT

Information on known clay and shale deposits in British Columbia is summarized in Tables* III and IV, and their geographical distribution is shown on the accompanying key map. In presenting these data, an effort has been made to include not only those deposits which were examined by the writers, but also those on which published information is available. On the other hand, only those clays and shales which show some ceramic promise are noted, many others having been examined and tested but not included. All ceramic tests on materials collected by the writers were made by the Ceramic Branch of the Bureau of Mines, Ottawa.

Apart from the tabulated data discussed above, no attempt had been made to deal with all the deposits specifically in the text of the report. However, for the more populated regions of the Province, brief outlines of the known and potential clay resources are given. The only deposits dealt with in detail are those of Sumas Mountain, Blue Mountain, and Giscome Rapids.

SOUTHERN VANCOUVER ISLAND AND GULF ISLANDS

General references:—

Southern Vancouver Island, *Geol. Surv., Canada,* Mem. 13, 1912.
Victoria and Saanich Areas, *Geol. Surv., Canada,* Mem. 36, 1913.
Nanaimo Area, *Geol. Surv., Canada,* Mem. 51, 1914.
Texada Island, *Geol. Surv., Canada,* Mem. 58, 1914.
Sooke and Duncan Areas, *Geol. Surv., Canada,* Mem. 96, 1917.

Locations on key map are indicated by ringed numbers.

Clay deposits are of widespread distribution on southern Vancouver Island and on certain of the Gulf Islands. Most of those of commercial interest occur near the bottom of the series of stratified sands and gravels of Puyallup Interglacial age and usually less than 100 feet above sea-level. The characteristic clay type of the region, typified by deposits worked in Victoria (28), at Sidney (24), at Tod Inlet (26), on Sidney Island (25), Texada Island (7), and near Duncan (20), Ladysmith (18), and Nanaimo (17), is yellowish grey and, although somewhat sandy, has good plasticity. For the most part, deposits are quite consistent in quality, although commonly containing numerous pebbles, and occur in beds from 10 to 20 feet thick.

In general, the clays discussed above are similar in characteristics wherever they are found and differ mainly in the proportion of sand and pebbles present. The finer-grained occurrences have good workability and are suitable for the manufacture of structural products by soft-mud or stiff-mud processes, maturing at low temperature to a good red colour.

The following properties are characteristic of the clays under discussion:—

Chemical Analysis

	Per Cent		Per Cent
SiO_2	60–65	MgO	.2–1
Al_2O_3	15–20	Alkalis	Trace
Fe_2O_3	7–9	Comb. water	5–6
CaO	3–5		

* *See* page 46 for Table III and page 56 for Table IV.

Ceramic Properties

Water of plasticity: 20 to 30 per cent.
Workability: Good.
Drying: Satisfactory.
Firing characteristics:

Cone	Shrinkage (Per Cent)	Absorption (Per Cent)	Colour	Remarks
04	2.0	13.0	Salmon red.	Hard.
02	7.0	2.0	Red.	Steel hard.
1	8.9	0.2	Brown.	Steel hard.

P.C.E.=3.

Interglacial clay of the above nature is currently worked at Victoria and Sidney and in the past has been utilized at plants near Duncan, Ladysmith, Nanaimo, and on Sidney Island. It is also known to underlie most of the northern end of Saanich Peninsula and to occur at many points around Victoria, Duncan, Nanaimo, Nanoose, Ladysmith, and elsewhere along the east coast of Vancouver Island. Clays of similar nature and geological relationship occur on Sidney, James, Thormanby (13), and other Gulf Islands and on the northeast coast of Texada Island, as well as in the Alberni (12) district.

In places the above deposits are underlain by a very fine-grained plastic blue clay. This clay is unsuitable for ceramic use alone owing to its excessive shrinkage, but it might be of interest as an additive to increase plasticity where needed.

Shales on Vancouver Island belong to the Nanaimo series of Cretaceous age, and although abundant in many parts of the area, they are mostly too hard and sandy to be of value for ceramic use. However, in places members of the Haslam, Cedar and Northumberland formations are sufficiently fine grained to be used for clay products.

At present good-quality dry-press brick is made from surface shale of the Northumberland formation on Gabriola Island (16), and within the past few years dry-press brick was made from an extensive deposit of fine-grained shale belonging to the Haslam formation and outcropping on the Koksilah River (23) between Hillbank and Cowichan Stations. In the past, Cretaceous shales have been utilized for brick manufacture, more or less successfully, at East Wellington (15), Union Bay (9), and on Pender Island (22). Undeveloped shales which show some promise for ceramic use occur near Courtenay (8), Alberni (11), Comox (8), and Nanaimo (15).

General characteristics of the usable Cretaceous shales of the area are typified by the following data from ceramic tests on shale from Evans, Coleman and Evans pit on Gabriola Island (16).

Water of plasticity: 21 per cent.
Workability: Good, moderately plastic.
Drying: Satisfactory at 85 degrees Centigrade.
Firing characteristics:

Cone	Shrinkage (Per Cent)	Absorption (Per Cent)	Remarks
09	1.6	14.8	Fairly hard.
06	3.1	10.5	Very hard.
04	4.8	9.3	Very hard, salmon red.
02	8.8	2.4	Very hard, dark red.
1	9.3	0.6	Steel hard, brown red.

P.C.E.=10½.

In general, the shales under discussion have a much longer firing range than the clays previously discussed, although their plasticity is a little low for working by any other than the dry-press process.

Although the occurrence of fireclay in association with the coal seams of the Nanaimo and Comox areas has been rumoured and is even discussed in some of the earliest literature, testing has failed to disclose any shales which are appreciably more refractory than the above. Some of this so-called " fireclay " from the Wellington No. 1 Pit, Extension, and Union Collieries was used in the manufacture of sewer-pipe, partition-tile, and chimney-tile by the B.C. Pottery and Terra Cotta Company Limited of Victoria in the period from 1908 to 1918. It was a cone 8 clay.

LOWER MAINLAND AREA

General references:—

Vancouver Area, *Geol. Surv., Canada,* Mem. 135, 1923.

Soil Survey of the Lower Fraser Valley, Dom. Dept. of Agriculture, Pub. 650, 1939.

Howe Sound and Vancouver Area, *Geol. Surv., Canada,* Pub. No. 996, 1908.

In the Lower Mainland area both Interglacial and Recent clay deposits are common, although geological relationships are not as clearly defined as they are in the Vancouver Island area.

Stratified clay deposits, probably related to the Puyallup Interglacial deposits described on Vancouver Island, occur on the northeast shore of Howe Sound near its head (32), on the east shore of Anvil Island (31), at the heads of bays along the south shore of Gambier Island (30), and in a belt extending from Gibsons Landing to Sechelt along the main coast, at Welcome Point, and on the Thormanby Islands (13). The clay in these deposits is somewhat sandy and yellowish to bluish grey in colour and in most places contains fairly abundant pebbles. The characteristics of this material are typified by the following sample from the old Columbia Clay Company operation on the south side of Anvil Island (31):—

Upper yellowish-grey clay.

Workability: Good plasticity.

Drying: Fairly good, slight cracking at 80 degrees Centigrade.

Firing characteristics:

Cone	Shrinkage (Per Cent)	Absorption (Per Cent)	Remarks
010	0.35	16.74	Light red, fairly hard.
03	3.10	7.76	Good red, very hard.
1	Fused.		

Fairly extensive stratified deposits of very fine-grained highly plastic blue clay occur at several places in the area, notably in Capilano (33) and Lynn Valleys (34), near Port Moody (41), on the north shore of the Fraser River opposite Seabird Island, and typically in the vicinity of Haney (50) where more than 4,000 acres are underlain by this material. In general this blue clay cracks badly in drying and has a very short firing range but has been used successfully for many years by the Port Haney Brick Company, particularly for the manufacture of structural and drain tile. Characteristics of the Haney clay are as follows:—

Chemical Analysis

	Per Cent		Per Cent
SiO_2	58.5	CaO	6.5
Al_2O_3	21.1	MgO	0.5
Fe_2O_3	8.6	Ig. loss	4.8

Ceramic Characteristics

Workability: Very plastic but sticky, 46.2 per cent water, works fairly well.

Drying: Cracks badly at 85 degrees Centigrade.

Firing characteristics:

Cone	Shrinkage (Per Cent)	Absorption (Per Cent)	Remarks
010	2.0	17.4	Fairly hard, salmon red.
08	2.8	15.0	Fairly hard, salmon red.
06	5.7	9.7	Hard, salmon red.
04	9.7	0.6	Steel hard, brown red.
02	9.5	0.1	Steel hard, brown red.

P.C.E.=01½.

In practice, sand is added to control adverse drying characteristics.

In addition to the types described above, numerous deposits of grey, rather sandy clay occur throughout the area. For the most part, these are lensy in form, changing laterally into sand in many places within a short distance, although some are relatively extensive. This type has been worked at Ruskin (52), Sullivan (48), New Westminster (43), Port Moody (41), Cloverdale (49), and other places. Characteristics vary somewhat, but in general all the clays have relatively short firing ranges and fire to red to reddish-brown colours and are suitable only for structural products.

The shales of the Lower Mainland area are not widely distributed and are restricted to Tertiary age. The best-known occurrences are those of Sumas Mountain (59) and Blue Mountain (57), which are described in greater detail later as Chapters III and IV of this bulletin. However, in addition to these, shales of possible ceramic value occur on the south side of Burrard Inlet near the Second Narrows Bridge (38) and near Barnet Station (39), as well as on Kanaka Creek, several miles above its mouth, near Whonnock Station, on Whonnock Creek about a mile above its mouth, and at several points on Stave River. With the exception of the first two occurrences mentioned, the other deposits have not been examined, and their association with coal seams (*Geol. Surv., Canada,* Ann. Rept. 1887, Vol. III, Pt. 1, p. 67A) would suggest the possibility of fireclay occurring in similar relationship to that at Sumas Mountain.

PRINCE RUPERT TO PRINCE GEORGE

Little, if any, general geological information is available on the clay deposits along the Canadian National Railway from Prince George to Prince Rupert, hence no general references are given here.

No shales occur in the vicinity of Prince Rupert, but there are deposits of glacial clay on the Mainland and on adjacent islands (*Geol. Surv., Canada,* Sum. Rept. 1913, p. 233). In the Terrace (118) area a thick deposit of stratified clay occurs over more than 17,000 acres. It is well exposed to the north of the village, where brick was made at one time, and on the road to the airport about 1½ miles south of the village. The clay is light brown to grey, with an exposed thickness of more than 80 feet in finely stratified beds. It is very plastic and works well but tends to crack on drying. It matures at a low temperature to a hard red body and with the addition of sand would probably be suitable for the manufacture of common brick.

Similarly extensive deposits of fine-grained varved clay occur along the road south of Fraser Lake (116). Although brick was made here at one time on a small scale for local use, the clay requires addition of considerable non-plastic material to be suitable for commercial use.

About 1 mile north of Smithers (117) brick was made at one time from a deposit of fine-grained brownish-grey clay just east of the road. This material likewise has a short firing range and cracks badly in drying.

A considerable area around Vanderhoof (115) is underlain by clay, exposed in many places on the north bank of the Nechako River and in road cuts. This clay works well, dries satisfactorily, and, although some addition of sand may be necessary, is suitable for the manufacture of common brick.

Over 200,000 acres in the Prince George area are underlain by fine-grained varved clay beds up to 20 feet thick. This material was used for making brick at a site along the highway to Vanderhoof (108) about 2 miles west of Prince George and is also well exposed along the highway to Quesnel about 1 mile east of the city. In general, this clay works fairly well, dries satisfactorily, and could be used for common brick and tile.

Several occurrences of Tertiary shales and clays of considerable potential importance are found in the Prince George area. Most interesting is the china-clay deposit at Giscome Rapids (111), 20 miles north of Prince George on the west bank of the Fraser River (*see* p. 30), but in addition an interesting series of shales and clays occurs along the Canadian National Railway at Mile 13 (109) and at Mile 19 (110). At the former point a 5-foot bed of almost white clay occurs in the river bank below the track. Although requiring some non-plastic material for safe drying, this clay works well and fires to a dark-cream colour around cone 1. This, coupled with long firing range, gives the clay possibilities for pottery as well as facebrick, etc. At the latter locality there is a series of bentonitic clays which are unsuitable for ceramic purposes, but associated with them is a bed of light-grey clay of similar characteristics to that at Mile 13. Should a demand arise for high-quality pottery or even facebrick clays in the north, the Tertiary formations in the vicinity of Prince George would bear close prospecting, as well as those along the Fraser as far south as Alexandria (103).

PRINCE GEORGE TO CLINTON

General references:—

Lillooet to Prince George, *Geol. Surv., Canada,* Mem. 118, 1920.
Soda Creek to Quesnel, *Geol. Surv., Canada,* Sum. Rept., 1931, Pt. A, p. 58.
Unpublished manuscript—P.G.E. Survey, Vol. 2.
Fraser River Tertiary Drainage-history in Relation to Placer-gold Deposits, B.C. Dept. of Mines, Bull. 3, 1940.

Surface clays suitable for the manufacture of common clay products occur at many points within the area but have not been studied in any detail owing to the lack of population in the territory.

Deposits of Tertiary shales and clays are widespread, particularly along the Fraser River north of Soda Creek. A Tertiary clay was formerly utilized at Quesnel (104) for the manufacture of common brick, but other than this there is no record of other clay-product manufacture within the territory.

The most interesting known clay in the area is a cream-burning stoneware clay occurring in a bed about 15 feet thick on the east bank of the Fraser River at the foot of the so-called Big Bend (105), about 6 miles north of Quesnel. Detailed prospecting of the numerous occurrences of Tertiary clays and shales along the Fraser and tributary streams might well reveal other deposits of high-grade clays.

SOUTHERN INTERIOR

In general, the clay resources of the southern interior of the Province are restricted to surface clays suitable only for the manufacture of common structural products. With the exception of the deposits in the Princeton (77) and Merritt (74) areas and a fine-grained shale on Lizard Creek (92) near Fernie which has excellent properties for facebrick, there are no known shales suitable for ceramic purposes. In the Princeton and

Merritt areas no high-grade ceramic clays are known, although considerable testing has been done at various times for fireclays in connection with the coal seams. In this territory, however, bentonite deposits occur at many places (*see* description, p. 33).

The Cretaceous shales of the Fernie area were tested for possible fireclay and for high-grade brick clay, but no refractory shales were found, and all proved too hard and sandy to be workable for any purpose.

At present there is no manufacture of clay products in the interior of the Province, although, in the past, plants have operated at many points. The most recent efforts within the past few years were at Grand Forks (81) and at Falkland (67).

CHAPTER III.—SUMAS MOUNTAIN AREA

(49° 122° S.E.)

Localities 56, 59, 60, and 61 on key map, *see also* Figures 2 to 7, inclusive.

A valuable series of shales, including the only true fireclay known in British Columbia, occurs in sedimentary rocks that cap the southwestern end of Sumas Mountain in the vicinity of Kilgard, 50 miles east of Vancouver.

H. Ries* has described the deposits briefly and has shown the results of numerous tests on various samples from the shale beds. References are made to the shales in the Annual Reports of the British Columbia Minister of Mines.†

The area mapped is covered with glacial drift and thick brush, so natural outcrops, except for those of certain conglomerate beds, are scarce. The underground workings and the logs of diamond-drill holes, however, furnish much information about the deposit.

The shales are part of the Eocene Huntington formation. In the area under discussion this formation consists of more than 1,200 feet of interbedded shales, sandstones, and conglomerates. These sedimentary rocks unconformably overlie basement rocks, mainly plutonic, but in part possibly volcanic and sedimentary.

The surface of the basement rocks has a general southerly to southwesterly slope but is irregular with localized humps and hollows. One of the hollows forms the rather restricted basin that contains the valuable fireclay seam. A zone of altered, highly kaolinized material between the Tertiary sediments and the underlying rocks suggests that a period of intense weathering of the basement formation preceded the deposition of the sedimentary series. The thickness of this kaolinized zone varies from place to place but is known to be at least 70 feet at a stripping in the ravine 500 feet north of the portal at the Richmix Fireclay mine. The kaolinized material was recognized in the diamond-drill holes, and it appears in the floor of both the Old Clayburn Fireclay mine and the present Kilgard Fireclay mine. In both mines, along the western limits of the workings, the fireclay seam ends at the kaolinized zone (*see* Fig. 5).

The lower part of the Tertiary series consists of alternating beds of shale and sandstone with a few thin lignite seams. Higher up, the shale beds are fewer and thinner, and thick beds of conglomerate become numerous. The sediments are believed to be part of the Eocene delta of the Fraser River. As such, one would expect the beds to lens and wedge, this feature is present, and it is common to find gradations from shale through sandy shale to fine sandstone and back to shale along the strike in a single stratum. Exceptions to these variable beds are the fireclay seam and the massive conglomerate beds, that show excellent continuity over considerable areas (*see* Fig. 2). The general strike of the formation is northwesterly with a gentle dip to the southwest. However, local variations in attitude are present, as indicated in Figure 3.

The general nature of the sedimentary sequence is illustrated by the four selected sections shown in Figure 6 and by the diamond-drill core logs shown in Figure 7. Figures 4 and 5 indicate the attitude of the rocks.

The characteristics of the different shale beds vary greatly. At least nine different shale seams have been worked at one time or another, and, of these, all the high-grade beds are below the No. 2 conglomerate (Fig. 2). The sediments above this conglomerate horizon become increasingly sandy and, as far as known, contain only one or two shale members, and these are suited only for the manufacture of red or buff brick. At the present time production is from four different shale beds known by the names Fireclay, No. 4B, No. 9, and Red Shale.

* *Geol. Surv., Canada,* Mem. 24E, pp. 126–138 (1912); 25, pp. 76–77 (1913); 65, pp. 15–17 (1915).
† *See* particularly 1908, pp. 186–187, and 1947, pp. 205–206.

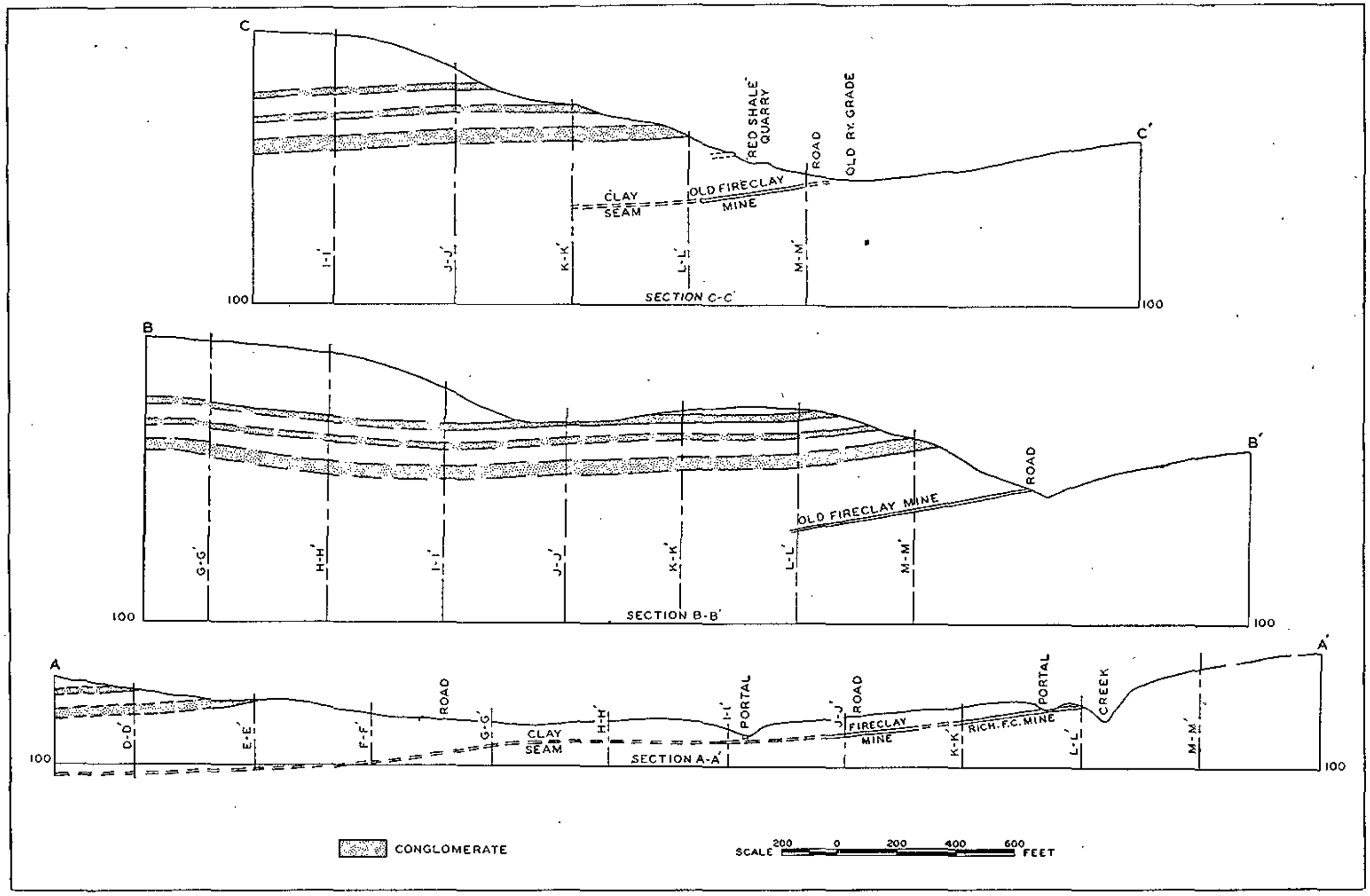

Fig. 4. Sumas Mountain—Sections A-A' to C-C' indicated on Figure 3.

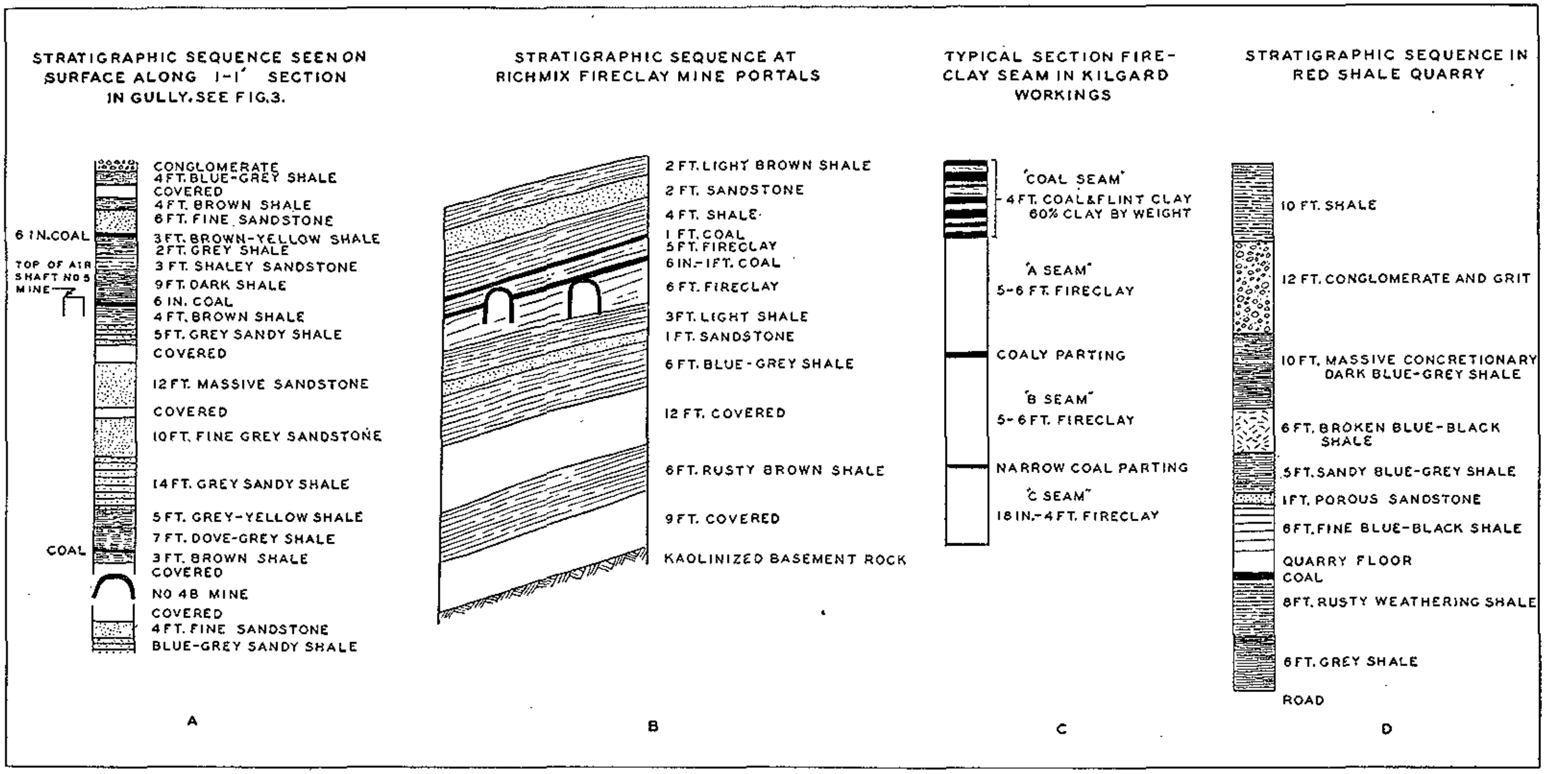

Fig. 6. Sumas Mountain—selected vertical sections.

The Fireclay seam is the most valuable of the shale beds in the formation. It has been worked by the Clayburn Company in the Old Fireclay mine on the north slope of the mountain, in the present Fireclay mine at Kilgard on the south slope; and also by the Richmix Company in an area southeast of Kilgard (*see* Fig. 3). The seam is near the bottom of the series, being directly on the weathered surface of the basement rock in some places. The eastern limit of the Fireclay seam is in the gully along the contact between the sedimentary series and the basement rocks indicated along the east edge of Figure 2. In this gully the fireclay outcrops at the surface with from 35 to 70 feet of kaolinized altered material between it and the basement rock. The contact surface and the Fireclay seam dip more or less uniformly to the south and west from the gully. However, the basement rock surface soon reverses its dip and rises to cut off the Fireclay seam along a line roughly parallel to and about 1,200 to 1,400 feet west of the gully. This feature has been encountered in both the present Fireclay mine and the Old Fireclay mine where altered basement rock was met, and mining in a westerly direction had to end. Diamond-drill holes Nos. 1 and 4 bottomed in bedrock without passing through fireclay, showing that the Fireclay seam does not extend as far west as these holes (*see* Fig. 3). The north and south limits of the Fireclay seam are unknown; when mining was discontinued in the Old Fireclay mine, the seam was still good to the north; in the present Fireclay mine it is strong in the southern faces of the workings, and diamond-drill hole No. 5 indicates its continuation at least that far to the south. It seems certain that the fireclay is continuous between the Old and present Fireclay mines.

In summary, the Fireclay seam was deposited in a basin that averages about a quarter of a mile east and west, is of unknown length north and south, and is arc-shaped concave to the west. The Richmix diamond-drill hole indicates that the original basin of deposition deepens to the southwest and that in this direction there may be a whole new series of shales below the exploited fireclay bed.

A representative section of the Fireclay seam as found in the Kilgard Fireclay mine is shown in Figure 6. The type section is 3 to 4 feet of coal interspaced with clay bands, the latter totalling over 60 per cent, by weight, of the seam. This clay is a fairly typical flint clay with a P.C.E. of 33+. Underlying this " coal " seam is the "A" seam, consisting of 5 to 6 feet of clay with a P.C.E. of 31–32, that in turn is underlain by a coaly parting 1 to 6 inches thick. Below this is the " B " seam of 5 to 6 feet of fireclay with a P.C.E. of 30+, underlain by a thin carbonaceous parting that in turn is underlain by another bed of fireclay, the " C " seam, from 1½ to 4 feet thick, with a P.C.E. of 29+. The fireclay deposit is very uniform, and a series of samples throughout the present mine shows a variation in P.C.E. of no more than half a cone in the same seam. Along the western face of the workings the " coal " seam and the "A" seam are consistent in thickness, but " B " seam narrows to about 2 feet, and " C " seam thickens and changes to a light-coloured clay streaked with iron oxide. This represents the northwest side of the original basin of deposition. Seam "A" is rather more siliceous and less refractory along the edge of the deposition basin than elsewhere. In practice the main " coal " seam forms the roof of the workings, and "A" and " B " seams are mined together as a 12-foot section.

The Fireclay seam consists of dark-grey non-calcareous shale. A sample of run-of-mine material worked well and was fairly plastic when tempered with 14.5 per cent water. It dried safely at 85 degrees Centigrade with an average drying shrinkage of 4 per cent. Firing behaviour is as follows:—

Cone	Fire Shrinkage (Per Cent)	Absorption (Per Cent)	Colour	Remarks
01	2.7	11.0	Pinkish white.	Hard.
2	3.5	9.7	Pinkish white.	Hard.
6	4.3	8.5	Greyish white.	Very hard.
9	4.0	6.6	Light buff.	Very hard with many specks.

P.C.E. = 31.

This is classed as a moderately dense firing refractory fireclay. A chemical analysis made in 1908 follows: SiO_2, 60.85; Al_2O_3, 35.27; Fe_2O_3, 2.75; CaO, 0.25; MgO, trace; alkalis, 1.88.* Recent analyses indicate the Fe_2O_3 content to be under 2 per cent, in the material used today.

The Clayburn Company mines the Fireclay seam in its Fireclay mine at Kilgard. Room-and-pillar method is used, and an average seam thickness of 12 to 15 feet is removed. In 1948,† 26,150 tons of clay was mined and used in the manufacture of refractories. The same company formerly worked the Old Fireclay mine near Straiton, half a mile to the north, on the other side of the ridge, but ceased work there when the manufacturing plant was moved from Clayburn to Kilgard in 1930. The Richmix Company also mines shale from the Fireclay seam from property adjoining the present Clayburn Fireclay mine to the east and southeast. Up until the summer of 1950, room-and-pillar underground mining was used. When the seam was worked out to the property boundaries, the company retreated up the slope, pulling pillars. Near the surface, underground mining was stopped, and the overburden was bulldozed off in preparation for strip-mining, which is now in progress.

No. 4B mine is worked by the Clayburn Company on an 8-foot thick bed of grey non-calcareous shale that has a coal parting, as much as 6 inches thick, about 2 feet above the floor. The old No. 4 mine workings adjoining No. 4B to the southeast removed from 9 to 11 feet of grey shale from below the coal. The two seams overlap in some places. The shale is quite uniform in quality throughout the workings. In a test, a sample worked well, with good plasticity when tempered with 13.6 per cent water. At 85 degrees Centigrade it had a slight tendency to crack and shrank 3.7 per cent on drying. Firing characteristics are as follows:

Cone	Fire Shrinkage (Per Cent)	Absorption (Per Cent)	Colour	Remarks
2	2.2	12.2	Pink-white.	Fairly hard.
6	3.0	10.4	Grey-white.	Hard.
9	2.4	9.6	Grey-buff.	Hard, numerous iron specks.

P.C.E.=20+.

It is classed as a grey to buff open-burning low-refractory fireclay. It is used chiefly in the manufacture of sewer-pipe and also as a base for acidware.

The No. 4B seam is worked underground by room-and-pillar methods. In 1948 production was 5,925 tons of shale.

Little is known about the extent of the No. 4B seam apart from where it has been mined. Assuming continuity comparable to that of the Fireclay seam, No. 4B should lie immediately below the Red Shale quarry and it should outcrop in the vicinity of the Clayburn plant.

In the No. 9 mine of the Clayburn Company, room-and-pillar methods are used to mine a seam of light-grey slightly calcareous shale that varies in thickness from 9 to 14 feet. The roof over most of the workings is massive conglomerate. As with the No. 4B seam, outcrops are too few to permit determination of continuity of the seam, although within the mine the shale is quite homogeneous. Tests indicate that a sample of this shale was plastic and worked well when mixed with 18.1 per cent water. It cracked badly at 85 degrees Centigrade under fast drying, but was satisfactory under slow air-drying conditions. Average drying shrinkage was 4.8 per cent. Firing characteristics are as follows:—

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* *Minister of Mines, B.C.*, Ann. Rept., 1908, p. 188.

† Because the Kilgard plant was destroyed in 1949 and the new plants at Kilgard and Abbotsford were not ready for use until late in 1950, production in 1949 and 1950 was much less than for normal years.

Cone	Fire Shrinkage (Per Cent)	Absorption (Per Cent)	Colour	Remarks
06	0.7	15.1	Pink-grey.	Fairly hard.
04	1.9	13.3	Pink-grey.	Hard.
01	4.0	9.1	Dark pink-grey.	Very hard.
2	4.3	7.7	Dark pink-grey.	Very hard.

P.C.E. = 13.

The clay is very unusual as far as fired colours are concerned, and it shows a long firing range.

This shale is used for facebrick and is mixed with clay from No. 4B seam for various non-refractory purposes, including acidware. The production from No. 9 mine in 1948 was 5,450 tons.

Clayburn Company's Red Shale bed is worked by an open quarry on the north side of the mountain near Straiton (*see* Fig. 3). The shale is not red, being chiefly blue-black to grey (*see* Fig. 6 D), but when it is burned it produces a dark-red brick. The shale works well when mixed with 22 per cent water but cracks on quick drying at 85 degrees Centigrade, although it dries safely under slow air-drying conditions with an average drying shrinkage of 6.2 per cent. It has a P.C.E. of 15. The shale shows good strong red colours and has a long firing range. It is used to make red facebrick. Production from this quarry in 1948 was 1,865 tons.

In addition to the four shale beds just discussed, four other shales have been worked on the Clayburn property, the mine workings on them being known as No. 5, No. 6, No. 7, and No. 8 (*see* Fig. 3). The No. 5 shale was buff burning, No. 6 was suitable for dry-press brick and sewer-pipe, No. 7 was buff burning, and No. 8, a lower part of No. 9 seam, was plastic and buff to grey burning.

Several other shales have been investigated in the surrounding territory at various times. None was found to be high grade, but several make good buff or red brick. A short adit was started on a buff-burning shale on the Richmix property east of Kilgard and some work was done on a red-burning shale from the Richmix property west of Kilgard (*see* Fig. 3). A series of good red- and buff-burning shales is known on the old Atlas Clay Products property (also known as the Fooks property), about a mile west of Kilgard (*see* Fig. 2). Over the ridge to the north, the Coutura adit was started on a 6-foot bed of light-grey sandy shale and the Thornton adit was begun on a 7-foot seam of grey-burning plastic shale. These latter two are difficult to correlate directly with the Kilgard workings and may represent new seams; however, stratigraphically the Coutura corresponds roughly to the No. 9 mine and the Thornton to No. 4B mine. The Fraser Valley Brick Company quarry is on the west end of Sumas Mountain, 2 miles due west of Kilgard. This quarry was opened on a 40-foot bed of blue shale that weathers brown. The raw shale showed poor workability but had a moderately long firing range with a good dark-red colour when fired and had a P.C.E. of 3. The weathered phase of this shale, although somewhat short and flabby, had a long firing range, good dark-red colour, and a P.C.E. of 13+.

Three companies have operated workings on Sumas Mountain in recent years. In a plant 1 mile northeast of Abbotsford, Abbotsford Fire and Pressed Brick Company made several spasmodic unsuccessful attempts to manufacture dry-pressed brick from the blue shale of their quarry. It is felt that with proper handling an excellent product could be made from this shale, past failures being due to improper handling and inadequate firing temperatures. Fraser Valley Brick Company has recently taken over this plant.

Richmix Clays Limited has mined fireclay from the main Fireclay seam from ground east of and adjoining the Clayburn property at Kilgard. Some of this fireclay was exported to the United States in the raw state, and the rest was made into refractories at the Richmix plant in Vancouver and other local plants.

Clayburn Company Limited, the largest clay-products company in British Columbia, has been the major exploiter of the Sumas Mountain shales, having been in production for over forty years. The following account of the present operations of the company has been written from information supplied by R. M. Hungerford, managing director of the company.

Clay products are made in two plants by the Clayburn Company—one at Kilgard and the other at Abbotsford.

The Kilgard plant employs an average of fifty men and produces about 1,000 tons of sewer-pipe and flue-lining per month. The main production building is of steel and brick with a saw-tooth type roof. This plant has six beehive down-draught oil-fired kilns in which the sewer-pipe is burned and a continuous-type kiln of eighteen chambers in which flue-lining is burned.

Raw shale from the mine, which is a few hundred yards north of the plant, and grog are first passed through a crusher. From the crusher, the material passes on to dry-pans, then screens, and on into an International Hawk de-airing machine that is connected to a hydraulic press where the sewer-pipe or flue-lining is formed.

After the wares are produced at the machine, they are loaded on to steel pallets and transported by lift truck to the drying floor, where they remain until ready for setting in the kilns. They are then transported on the same pallets to the kilns, where they are set for burning. After the wares are burned and cooled, they are removed to the yard for stocking.

The sewer-pipe produced has a vitrified salt glaze, and the flue-lining is a refractory lining.

The other Clayburn plant is on Canadian Pacific Railway trackage in the village of Abbotsford. Facebrick, firebrick, and special refractory shapes are produced here. An average of thirty men is employed in the plant. About 2,000 tons of ware is produced per month from raw shale trucked to the plant from the company mine at Kilgard.

This plant is equipped with a Provincial 5-ton overhead bucket-type crane, crusher, screens, Maximuller dry-pan, Stearns magnetic separator, two International heavy-duty dry presses, Pearne and Lacy block press, and a Steele de-airing machine for the production of stiff-mud brick. It is also equipped with an oil-fired Allied tunnel kiln 300 feet long and a pre-drier 150 feet long.

The products are set on the cars at the machines and remain on these cars until they have passed through the kiln and are finished wares. The kiln cars are then unloaded and the wares taken on pallets by lift truck to the stock-sheds, or loaded into railway cars on the siding.

The company is now producing dry-pressed high heat duty, dry-pressed intermediate heat duty, and stiff-mud firebrick in both standard and special shapes. Facebrick is also produced by the dry-press and stiff-mud methods.

Each plant is heated with a low-pressure boiler which also pre-heats the oil for the kilns.

CHAPTER IV.—BLUE MOUNTAIN

(49° 122° S.E.)

Locality 51 on key map.

Seven Crown-granted mineral claims in Section 2, Township 4, Range 4, west of the 7th meridian, New Westminster Land District, cover an area in which sedimentary rocks containing beds of shale are exposed. The outcrops are about 2,200 feet above sea-level in gullies on the southern and western slopes of a ridge, known locally as Blue Mountain, 7 miles north of Whonnock, a village on the north bank of the Fraser River 30 miles east of Vancouver.

The top end of the old Baines logging-road is about half a mile from the main shale outcrop. This road, now impassable to vehicles except for a mile at the bottom end, extends 3¼ miles northward from a point on the Dewdney trunk road half a mile west of Thirtieth Avenue.

Shale outcrops in an area that is heavily timbered with large trees. With few exceptions, outcrops are found only in ravines and in the beds of creeks. The creeks are tributaries of two main streams—Gold River, which flows south and then westerly across the northwestern part of the region, and Whonnock Creek, which flows south along the eastern margin of the area.

A brief report on the property containing the results of tests on shales from the deposit was published by H. Ries* in 1915. Short references to the deposit are made in Annual Reports of the British Columbia Minister of Mines.†

This report is based on a three-day examination of the property made in September, 1950. The Ceramics Section of the Department of Mines and Technical Surveys, Ottawa, kindly made ceramic tests on samples obtained in the course of the examination.

In the map-area (*see* Fig. 8) the rock sequence consists of a series of conglomerates, shales, and sandstones that overlies a granitic mass.

The granitic rock varies in colour and in composition but, in general, is rather dark and is composed of feldspar and hornblende. The study of one thin section of the rock from an outcrop on Gold River near the north of Lot 3210 (*see* Fig. 8) indicated it to be a diorite composed essentially of andesine and hornblende. Other facies probably exist, but for the purposes of this report all outcrops of a granitic type will be referred to as diorite. The diorite outcrops in the northern and eastern parts of the map-area.

A coarse conglomerate overlies the diorite. In the bed of Gold River the conglomerate pebbles are mostly dioritic, but a few are volcanic. They vary in diameter from a quarter of an inch up to 3 feet and are fairly well rounded. The maximum observed thickness of the conglomerate was 15 feet. Toward the top of the conglomerate bed the pebble size decreases, and the rock grades into coarse grey sandstone. In Whonnock Creek a similar coarse basal conglomerate is exposed, but the volcanic pebbles are missing. In the most southerly exposure in this creek the pebbles in the conglomerate are large on the diorite surface but upward grade quickly into smaller sizes and finally into sand size. A lateral size gradation is present on Whonnock Creek also, with pebble size decreasing upstream until at the most northerly contact seen, near the centre of Lot 3211, the conglomerate is missing and sandstone lies directly on top of the diorite.

The main shale exposures are along Gold River and its tributaries. Overlying the sandy top of the basal conglomerate is a 10-foot thick bed of bluish-grey sandy shale that contains a conspicuous amount of fine black mica flakes. This bed is, in turn, overlain by a bed of dark-red blocky shale at least 110 feet thick. The red shale is a dense,

* *Geol. Surv., Canada,* Mem. 65 (No. 53, Geological Series), pp. 2–15 (1915).

† *Minister of Mines, B.C.,* Ann. Rept., 1917, p. 290; 1926, p. 327.

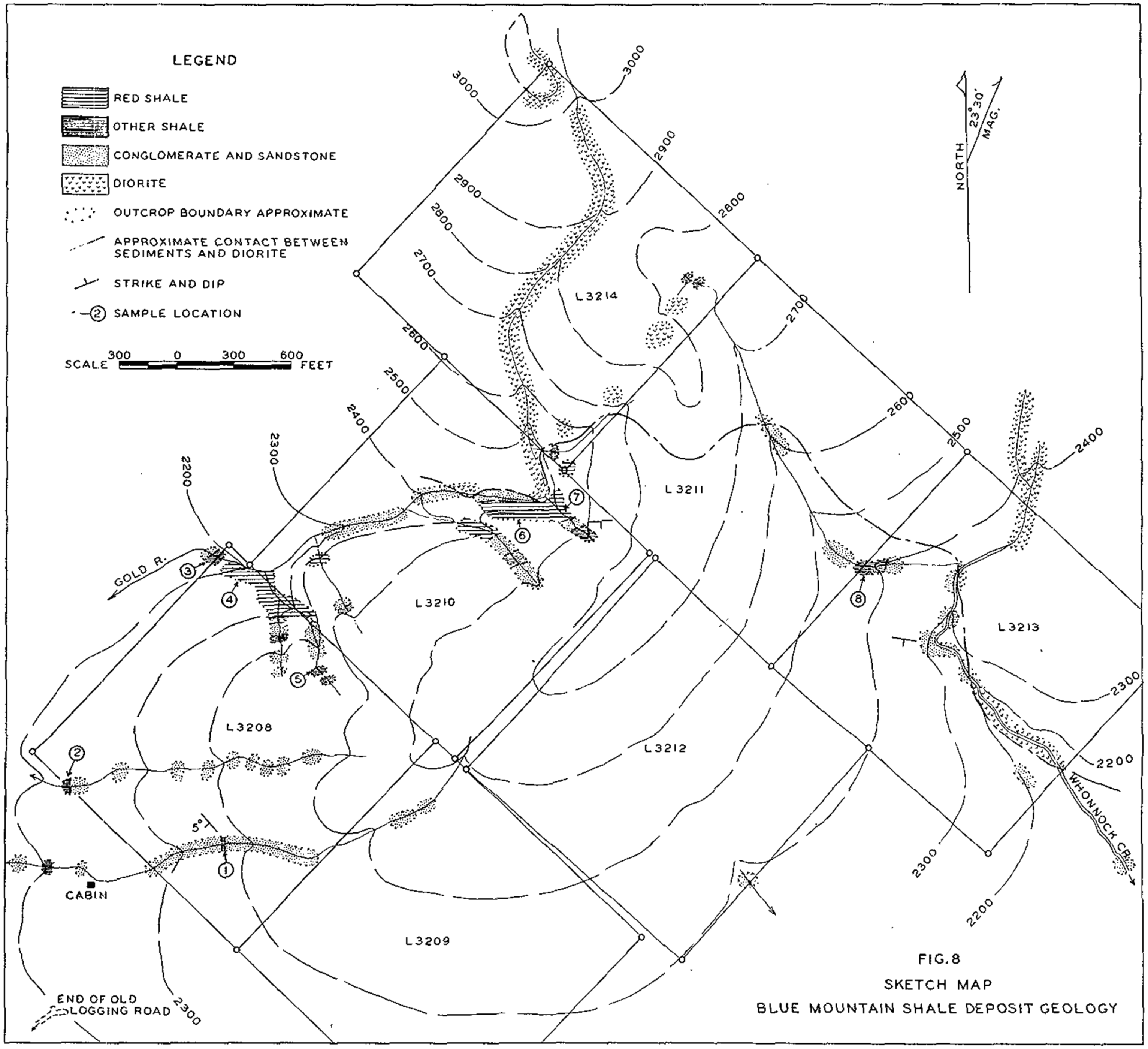


FIG. 8
SKETCH MAP
BLUE MOUNTAIN SHALE DEPOSIT GEOLOGY

massive looking rock that breaks with a conchoidal fracture. Except for the inclusion of a few scattered diorite pebbles, it is very uniform in appearance throughout and shows little sign of stratification. The red shale is overlain by at least 250 feet of brown sandstone and fine conglomerate with occasional thin beds of bluish, yellow, and brown shales. A small forked tributary of Gold River flows northwesterly along the boundary between Lots 3208 and 3210 and enters Gold River near the west corner of Lot 3210. This tributary exposes a good vertical section of the rock series. On this creek are three caved adits—two on its east fork and one on its west fork. Another good section of the series can be seen at the sharp bend in Gold River near the centre of the northeast side of Lot 3210. Here a steep rock bluff shows 135 feet of red shale overlain by 75 feet of micaceous sandstone and fine conglomerate with occasional thin shaly lenses, and this in turn is overlain by 15 feet of brown shale.

The rocks exposed in the beds of the two westerly flowing creeks that cross the centre of Lot 3208 are predominantly brown sandstone and fine conglomerate. Only three outcrops of shale were seen—two on the first creek north of the cabin and one on the other creek. The shale is a bluish colour and not more than 5 feet thick.

Only two exposures of shale were noticed in Whonnock Creek. The larger is where the north fork crosses the boundary between Lots 3211 and 3213. This is a bed of brown gritty shale about 10 feet thick. The second outcrop of brown weathering blue shale is near the head of the creek at the east corner of Lot 3214. The other exposures in the creek are of sandstone, conglomerate, and diorite. At the sharp bend in the main creek near the centre of Lot 3213 conglomerate and sandstone are exposed over a thickness greater than 70 feet. No red shale was found anywhere in the creek valley.

Toward the northeastern part of the map-area the sedimentary rocks strike east and west, but in the southwestern part of the area the strike swings around to the northwest. In all cases the dip is very flat to the south and southwest.

During the examination of the area eight samples of shale were collected. The sample numbers as listed below correspond to the location numbers indicated on Figure 8.

Sample No.

1. 5-foot bed, non-calcareous blue shale.
2. 5-foot bed, non-calcareous blue shale.
3. 15-foot bed, grey gritty shale.
4. Lower part of the red blocky shale bed.
5. 10-foot bed, yellow shale.
6. Lower part of red blocky shale bed.
7. Red blocky shale from above No. 6 in same bed.
8. 10-foot bed, brown gritty shale.

The results of ceramic tests carried out at Ottawa on the samples are summarized in the table on page 29.

In his report on the Blue Mountain shales Ries* describes tests carried out on four different shales and various mixtures of them. His results on the red shale (corresponding to sample No. 4) are similar to those given in the table on page 29. His second shale is blue, and he classes it as fireclay that fused at cone 30. No accurate location is given for this sample, but it apparently came from a bed above the red shale, possibly near one of the old adits. There is no statement as to the thickness of this blue shale. In the present examination, the only blue shale seen near the adits consisted of occasional beds less than a foot thick. The third shale mentioned by Ries is a grey shale from a tunnel (now caved) on the tributary to Gold River. Again no thickness is given for the shale bed. Ries concludes that this shale would make a dense brick and could possibly be used for sewer-pipe. Ries also mentions a white clay, apparently of irregular occurrence and

* *Geol. Surv., Canada,* Mem. 65, pp. 2–15 (1915).

of unknown quantity, that burns to a cream or buff colour and is practically vitrified at cone 15. It could probably be used for facebrick.

The shales on Blue Mountain are interesting and show possibilities at least for use in the making of facebrick. Further prospecting would likely reveal other occurrences of shale in the area to the south and west of the map-area, some perhaps of greater value than the known ones.

Sample No.	General Characteristics	Firing Characteristics					General Remarks
		Cone	Fire Shrinkage	Absorption	Colour	Miscel-laneous	
			Per Cent	Per Cent			
1	Requires 17.9 per cent water for working. Good plasticity, works well. Tendency to crack in rapid drying but safe in air drying. Average shrinkage on drying, 5.1 per cent.	04 02 1 4 9	1.7 3.0 4.0 5.7 5.0	13.8 11.6 10.0 6.9 1.8	Light salmon. Brown salmon. Dark salmon. Brown. Brown.	Fairly hard. Hard. Hard. Very hard. Vitrified.	P.C.E.=15. Possible use as stoneware clay.
2	Requires 16.7 per cent water for working. Short, poor workability. Safe in rapid drying. Average shrinkage on drying, 4.3 per cent.	1 4 9	3.3 3.7 4.0	12.6 12.5 11.9	Salmon. Dark salmon. Dark pink salmon.	Soft. Fairly hard. Fairly hard.	P.C.E.=20. Requires addition of plastic lower-fusing clay to lower maturing temperature and improve fired colour.
3	Requires 18 per cent water for working. Short but works fairly well. Safe in rapid drying. Average shrinkage on drying, 3 per cent.						P.C.E.=13. Briquettes crumble on firing. No economic value.
4	Requires 18 per cent water for working. Short, works fairly well. Safe in rapid drying. Average shrinkage on drying, 4.5 per cent.	1 4 9	3.7 4.3 4.3	12.7 12.5 11.3	Salmon. Salmon. Light red.	Fairly hard. Fairly hard. Fairly hard.	P.C.E.=20. Requires addition of more plastic lower-fusing clay to improve working properties.
5	Requires 24 per cent water for working. Fairly plastic, works well. Safe in rapid drying. Average shrinkage on drying, 6 per cent.	1 4 9	6.3 7.3 7.8	14.2 13.5 12.8	Salmon. Dark salmon. Dark salmon.	Fairly soft. Fairly hard. Fairly hard.	P.C.E.=23. Requires addition of lower-fusing material to lower maturing temperature and improve fired colour. Possible use for household-stove linings.
6	Requires 18.8 per cent water for working. Short but works fairly well. Safe in rapid drying. Average shrinkage on drying, 3 per cent.	1 4 9	2.3 2.3 2.5	14.1 13.9 13.2	Salmon. Light red. Light red.	Fairly soft. Fairly soft. Fairly soft.	P.C.E.=19. Requires addition of plastic lower-fusing material to lower maturing temperature.
7	Requires 16 per cent water for working. Very short, poor workability. Safe in rapid drying. Average shrinkage on drying, 2 per cent.	02 1 4 9	6.0 8.0 8.3 8.3	12.6 9.8 9.3 9.1	Red. Red. Red. Red.	Fairly hard. Fairly hard. Fairly hard. Very hard.	P.C.E.=15. Possible use for facebricks by dry-press process only.
8	Requires 17.4 per cent water for working. Very short, poor workability. Safe in rapid drying. Average shrinkage on drying, 2.4 per cent.	1 4 9	5.0 5.3 6.3	16.9 15.9 15.5	Light red. Red. Red.	Soft. Soft. Fairly soft.	P.C.E.=15. No value for ceramic products.

CHAPTER V.—GISCOME RAPIDS

(54° 122° S.W.)

A china-clay deposit is on Lot 3991, Prince George district, on the west bank of the Fraser River, near the foot of Giscome Rapids. Access is by the Hart Highway to a point about 19 miles north of Prince George and thence by branch road for 2.3 miles east to the river. The last mile of the branch road was impassable for vehicles in 1950 but could be opened up easily with a bulldozer.

In 1942 an area approximately 100 feet square on the river bank was stripped, a loading platform built, and 20 tons of clay mined and shipped to Vancouver by F. J. Beale, owner of the property. Little development work has been done, and most exposures are the result of natural agencies.

Holes drilled by hand-auger in 1947 on the stripped area indicate the deposit to be at least 35 feet thick at this point. Exposures occur at intervals for about half a mile along the river, and for about 300 feet west of and 40 feet above the water's edge. Farther to the west and continuing for more than a quarter of a mile is a relatively flat bench 50 to 60 feet higher than the river. The extension of the clay beneath this bench was not established owing to the impossibility of drilling through the pebbly overburden with the equipment at hand. On the basis of the evidence available, the deposit is considered to be of Tertiary age, sedimentary in origin, flat-lying, and extensive.

Figure 10 is a composite of drill-holes A and B. Drill samples were submitted for testing to the Mineral Dressing and Metallurgy Division, Department of Mines and Technical Surveys, Ottawa, and the complete results are shown in this table. In brief the important parts of the results are as follows:—

All samples were found to have good plasticity despite the fact that A, B, D, and E contained from 41 to 55 per cent sand. Drying behaviour at 85 degrees Centigrade was satisfactory in all cases. Softening points of unwashed clays ranged from cones 28 to 29 for D, E, and G, to cone 30 for A, and cone 31 for B, C, and F. Washed products from these samples had softening points from cone 31 for A to cone 31½ for D and cone 32½ for B. Samples B, C, E, and F burn to a good white at cone 8, and slightly off-white at cone 12, whereas samples A, D, and G burn to a cream colour in the same firing range. Clays B, C, E, and F (6 to 26 feet) are classed as excellent white open-firing clays of refractory grade, suitable for whitewares (porcelain and pottery) and refractories. Sample A, representing surface material (6 inches to 6 feet), burns to a somewhat darker colour but was considered to have possibilities for the same products. Clays D and G, although burning to a cream colour, are considered to have potential value for use in low heat duty refractories or mixed with less refractory clay for dense-firing ware. A 4-foot section of brownish clay, exposed at the river bank 400 feet downstream from the loading platform and considered to represent a lower horizon than the above materials, was sampled and tested. The clay fired to a dense cream to grey body at cone 12 (absorption 3.6 per cent), although its softening point was cone 28. It is probably suitable for products requiring body density such as saggers, glasspots, and certain refractories.

Although the clays in the drill-holes range from light grey, through blue-grey, to brown, their surface colour is creamy white wherever exposed, owing to the removal of organic matter by weathering. In the vicinity of the stripped area the weathered zone follows in a general way the contour of the ground and varies in thickness from 3 to 6 feet. In places the surface clay is heavily stained with iron, but otherwise its ceramic properties resemble corresponding unweathered material. The 20-ton lot taken out by Beale represents surface clay corresponding in horizon to parts of B and C but firing to a darker colour owing to the presence of considerable iron stain deposited by surface waters.

Clay from this deposit has been satisfactorily used by the Mineral Dressing and Metallurgy Division, Department of Mines and Technical Surveys, Ottawa, as an in-

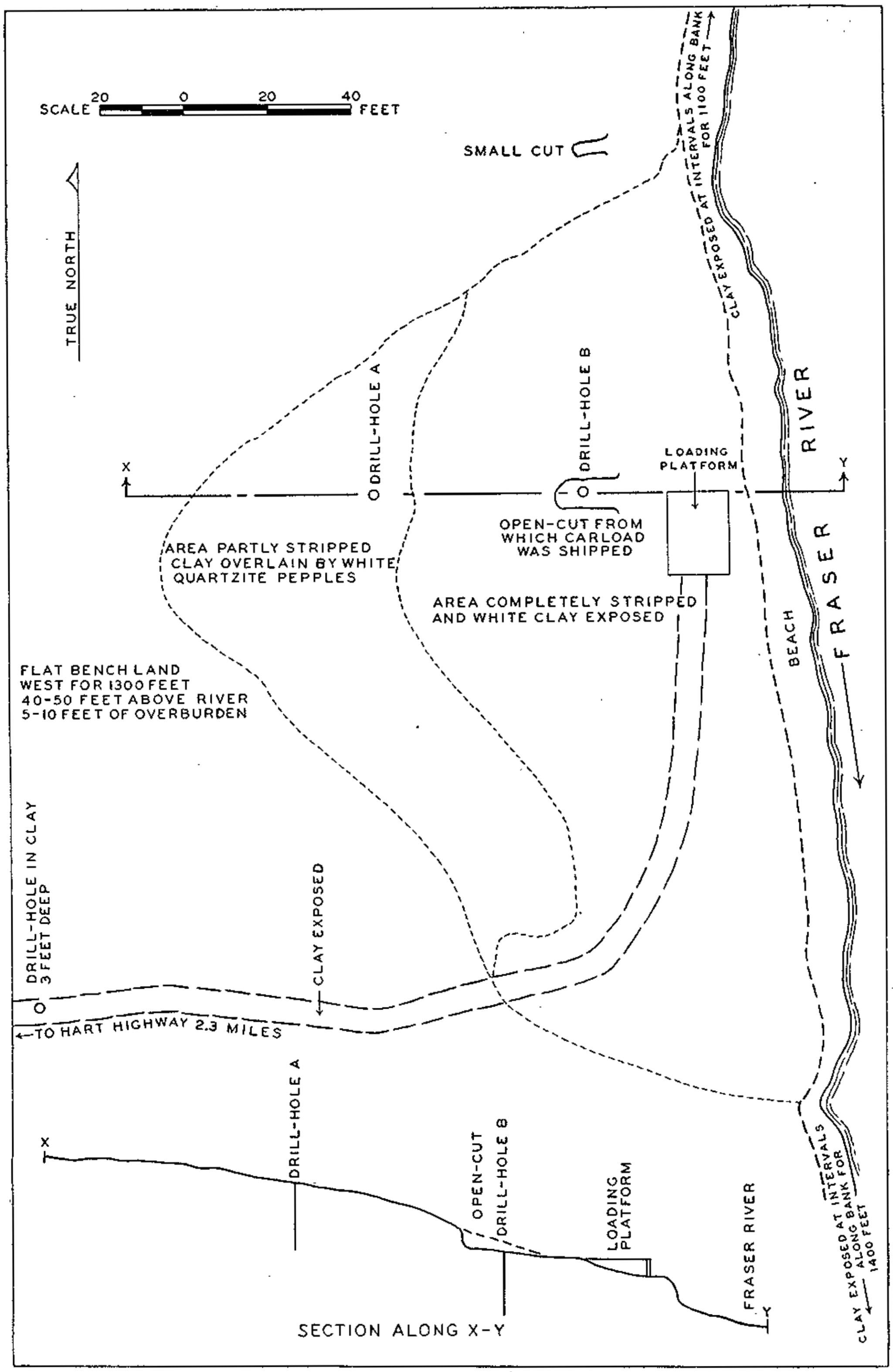
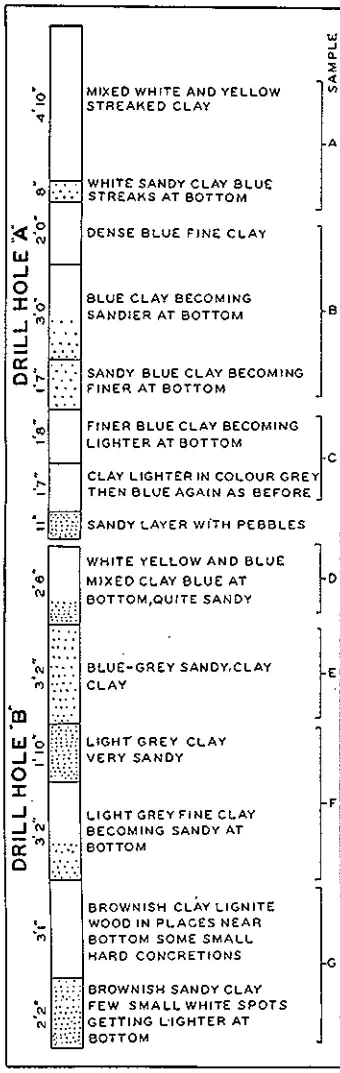


Fig. 9. Giscome Rapids china-clay deposit—geology.

gredient of a slip-cast porcelain body of standard composition, in which Giscome Rapids clay, owing to its plasticity, replaced not only china clay but ball clay as well. Washed material from the 20-ton lot has been used satisfactorily by Lambert Potteries, Vancouver, in the formulation of a number of whiteware bodies for throwing as well as casting.



SAMPLE	FIRING CHARACTERISTICS					REMARKS
	CONE	SHRINK	ABSORP.	COLOUR	HARDNESS	(DS = SHRINKAGE ON DRYING.)
A	02	1.3	14.5	CREAM	FAIRLY SOFT	P.C.E.=30. WASHED TO REMOVE 42.9% OF SAND RAISED P.C.E. TO 30+. WITH 24.3% WATER WORKS WELL, FAIR PLASTICITY, SLIGHTLY GRITTY. SAFE TO DRY AT 85°C. DS=4.8%
	2	2.3	13.5	LIGHT CREAM	HARD	
	8	3.0	11.1	LIGHT CREAM	HARD	
	12	3.3	10.2	CREAM	HARD	
B	02	1.3	14.5	WHITE	FAIRLY HARD	P.C.E.=31+. WASHED TO REMOVE 42% OF SAND RAISED P.C.E. TO 32.5. WITH 22.3% WATER WORKS WELL, FAIR PLASTICITY, SOMEWHAT SANDY. SAFE TO DRY AT 85°C. DS=4.4%
	2	3.0	12.0	WHITE	HARD	
	8	3.2	11.3	WHITE	HARD	
	12	4.0	9.0	WHITE	VERY HARD	
C	02	2.7	14.0	WHITE	FAIRLY HARD	P.C.E.=31.5. WITH 25.8% WATER WORKS WELL, GOOD PLASTICITY. SAFE TO DRY AT 85°C.
	2	3.7	11.4	WHITE	HARD	
	8	4.5	10.3	WHITE	VERY HARD	
	12	5.0	8.4	CREAM WHITE	VERY HARD	
D	02	1.6	15.0	PINK WHITE	FAIRLY SOFT	P.C.E.=28. WASHED TO REMOVE 41.1% SAND RAISED P.C.E. TO 31.5. WITH 24.5% WATER WORKS WELL, SLIGHTLY GRITTY. SAFE TO DRY AT 85°C. DS=5.5% SOME IRON SPOTS ON FIRING.
	2	2.6	12.0	PINK CREAM	HARD	
	8	2.4	11.6	CREAM	HARD	
	12	2.7	8.9	BUFF	VERY HARD	
E	02	0.3	13.8	WHITE	SOFT	P.C.E.=28. WASHED TO REMOVE 55% SAND RAISED P.C.E. TO 31.5. WITH 27.5% WATER WORKED WELL, SOMEWHAT SHORT. SAFE TO DRY AT 85%C. DS=3.6%.
	2	0.4	12.5	WHITE	FAIRLY HARD	
	8	0.8	11.5	WHITE	FAIRLY HARD	
	12	0.9	10.7	WHITE	HARD SPECKS	
F	02	2.0	15.3	WHITE	FAIRLY SOFT	P.C.E.=31. WITH 25.3% WATER WORKED WELL, GOOD PLASTICITY. SAFE TO DRY AT 85°C. DS=5.2%. TRACE IRON SPOTS ON FIRING.
	2	2.3	13.7	WHITE	HARD	
	8	4.0	11.2	WHITE	VERY HARD	
	12	5.3	8.4	WHITE-CREAM	VERY HARD	
G	02	2.1	16.8	WHITE	FAIRLY SOFT	P.C.E.=29. WITH 28.7% WATER WORKS WELL. SAFE TO DRY. DS=5.7%.
	2	3.0	15.6	WHITE	HARD	
	8	5.0	11.8	CREAM	HARD	
	12	6.0	8.8	BUFF	VERY HARD	

Fig. 10. Giscome Rapids china-clay deposit—drill sections.

Washing tests on various samples from this deposit, made by the British Columbia War Metals Research Board in 1943, gave the following results:—

(1) Sand recoveries of 23 to 43 per cent of original sample were made. Of the sands, approximately 40 per cent was +100 mesh and assayed: SiO_2, about 96 per cent; Al_2O_3, 1 per cent; Fe_2O_3 plus TiO_2, 2 per cent.

(2) It was found impossible, either by flotation or chemical bleaching, to produce a sufficiently white product acceptable for paper filler.

Considerable work is required to prove the extent of this deposit and the distribution of the various types of clay present. However, there seems little doubt that high-grade clays are available and that the deposit is large.

[Reference: *Geol. Surv., Canada,* Mem. 65, 1915, pp. 40–41.]

CHAPTER VI.—BENTONITE

General references:—

Geol. Surv., Canada, Memoirs: 25, 1913, p. 73; 243, 1947, p. 131; 249, 1948, p. 149.

Mines Branch, Dept. of Mines, Ottawa, Sum. Rept., 1918, p. 160.

Minister of Mines, B.C., Annual Reports: 1920, p. 169; 1923, p. 190; 1924, p. 175; 1931, p. 132.

Spence, H. S.: Bentonite, Mines Branch, Pub. No. 626, Dept. of Mines, Ottawa, 1924, pp. 14, 16, 17.

The name "bentonite" is used for clay materials composed principally of the mineral montmorillonite, a hydrous aluminium silicate. These clays have a somewhat greasy or waxy feel when dry and become very sticky when wet. There are two chief types of bentonite:—

(1) The Wyoming (western, swelling, high colloidal, or sodium) type that absorbs up to five times its weight of water and swells to nearly fifteen times its dry bulk volume in so doing. This type remains in suspension when dispersed in water and sets to a gel-like mass.

(2) The Mountain (southern, non-swelling, non-colloidal, or calcium) type that does not absorb much water, does not swell greatly, and does not remain in suspension, but is useful for decolorizing and bleaching purposes. Both types are characterized by a high base-exchange capacity—sodium for the former and calcium for the latter.

Bentonite varies in colour from creamy white to grey, blue, yellow, brown, red, and green. It is quite brittle when dry and exhibits a good conchoidal fracture. The usual occurrence is in Cretaceous or Tertiary bedded deposits often closely associated with coal seams or volcanic ash. The bentonite is believed to have formed by the devitrification and partial decomposition of volcanic ash. Outcrops are characteristically bare of vegetation and usually exhibit a peculiar crinkled coral-like appearance when dry.

The chief uses for bentonite are as a thickening and suspending agent in rotary oil-well drilling mud, as a bonding agent in foundry work, and as a decolorizing agent and catalyst in oil refining. It is also used in de-inking newsprint; as a bonding medium in firebrick, asbestos cements, insulating and acoustic plasters; for increasing the workability of cement mortars; in the manufacture of soaps and cosmetics; and in numerous other processes.

Bentonite is known to occur at various places in British Columbia. Keele* reported it from 17-Mile House on the Cariboo Highway and from the mouth of Gorge Creek in the Deadman River valley northwest of Kamloops. Large deposits occur near Princeton and in the vicinity of Quilchena. Bentonite has also been identified in beds in the banks of the Nechako River near Mile-post 19 on the Canadian National Railway west of Prince George.

The best-known British Columbia deposits of bentonite are in the Princeton district. Commercial production to date for the Province has been from a showing about a mile from Princeton in the first railway cut east from the railway bridge crossing the Similkameen River on the Princeton to Copper Mountain branch of the Canadian Pacific Railway. This outcrop shows a 14-foot bed of bentonite that dips at a slight angle into the hill. The upper 3 feet is brownish; below this is 7 to 8 feet of yellow-green clay; next, a

* Mines Branch, Dept. of Mines, Ottawa, Sum. Rept., 1918, p. 160.

thin seam of lignite coal; then a 4-foot bed of yellow clay underlain by shale. About 500 yards to the east the bentonite beds outcrop at slightly higher elevations along the south wall of the railway cut.

Half a mile east of the above showing light-coloured bentonite outcrops with an exposed thickness of 6 feet. This is half a mile by road from the railway. One other occurrence is known on the railway to Copper Mountain 5 miles from Princeton.

In the now flooded colliery of the former Princeton Coal and Land Company an 18-inch bed of creamy-white bentonite occurred between the lower coal seam and shale floor. This association with coal is common, as bentonite is found above and below most of the coal seams in the Princeton district.

Bentonite is also found in the vicinity of Quilchena, 15 miles east of Merritt. The main deposit is on the old Triangle Ranch (or Guichon property), 2¼ miles by road south of Quilchena and 8 miles by road southeast of the railway at Nicola. Here an 8-foot bed of bentonite conformably overlies a 5-foot bed of shaly lignite coal. The bentonite bed strikes north and south and dips into the hill at 30 degrees. The surrounding rocks are Tertiary volcanics.

Between 1926 and 1944 about 850 tons of bentonite from Princeton was marketed. Since 1944 there is no record of commercial production. For a time the Imperial Oil Company used this material for decolorizing oil in the Ioco refinery, but in recent years they have used an imported product. The Reliance Foundries of Vancouver tried the Princeton bentonite as a bond in steel moulding sands but gave it up in favour of imported clay. Similarly, the Consolidated Mining and Smelting Company ran some tests but found the British Columbia product inferior to imported bentonite.

A limited amount of testing has been done on the British Columbia bentonites. These tests indicate that the local clay is of the non-swelling or non-colloidal type of bentonite. It is less colloidal than that produced in Wyoming, North Dakota, or California; however, it has power equal to imported Fullers' earths but less than imported activated bentonites for decolorizing oils and for bleaching. The British Columbia material apparently cannot be "activated"; that is, acid-treated to increase its decolorizing power or regain this power after being used.

Chemical and physical data on representative samples of the Princeton and Quilchena bentonites, as compared to Wyoming material, are given below. These are partly from Mines Branch Publication No. 626 and partly from work done for the British Columbia Department of Mines by the Mines Branch laboratory at Ottawa.

Chemical Analyses

	Quilchena	Princeton	Wyoming
	Per Cent	Per Cent	Per Cent
Silica	68.78	68.60	59.57
Alumina	13.10	12.10	19.67
Ferric oxide	2.48	2.00	2.91
Ferrous oxide	0.22	0.32	0.26
Lime	1.87	1.84	0.66
Magnesia	1.83	1.84	2.46
Titanium oxide	0.22	0.14	Trace
Phosphoric acid	0.06	0.17	......
Soda	0.70	0.50	2.09
Potash	0.21	0.23	0.29
Sulphur	0.01	*Nil*	Trace
Sulphuric acid	*Nil*	0.61	......
Carbon dioxide	0.26	0.17	......
Carbon	0.08	0.08	......
Water at 105° C.	5.55	7.71	7.40
Water above 105° C.	4.64	3.24	4.73

Physical Analyses

	Quilchena	Princeton	Wyoming
Water absorbed by 1 gram of clay	*1 to 1.8 gr.*	*1.6 gr.*	*4.95 gr.*
Fusion point (Seger cone)	11 to 15	14	10
Specific gravity (clay dried at 105° C. for two hours)	2.44	2.55	2.78
Refractive index	1.547	1.549	1.557
Moisture content (per cent)—			
Air dried	3.55	4.92	3.67
Heated to 500° C.	2.11	2.57	3.49
Heated to 600° C.	1.64	1.48	3.43
Heated to 700° C.	0.68	0.78	0.77
Swelling property completely destroyed at	500° C.	400° C.	600° C.

Suspension

Ten grams of clay put in 350 cubic centimetres of water and agitated for three hours, then screened. Solution passing through the screen allowed to stand for twenty-four hours and then decanted. Percentage of dispersed clay is regarded as the colloidal fraction.

	+200 Mesh	Settled Clay	Dispersed Clay
	Per Cent	Per Cent	Per Cent
Quilchena	2.18	76.72	21.10
Wyoming	0.95	29.75	69.30

CHAPTER VII.—MISCELLANEOUS CERAMIC MATERIALS IN BRITISH COLUMBIA

INTRODUCTION

Little work has been done on any of the known deposits of miscellaneous ceramic materials other than clay, and no systematic search for them has been made because the demand for them in British Columbia is small. The only commercial production for ceramic use of any of these materials has been from the pyrophyllite deposit at Kyuquot. However, some laboratory work has been done on a few of the minerals, and deposits of most of them are known.

FELDSPAR

No information is on record of any deposit of feldspar in British Columbia suitable for ceramic use in its raw state. Intrusive rocks containing major proportions of potash and soda feldspar are found in various parts of the Province, but all contain too much iron for commercial exploitation. It is quite possible, however, that feldspar of ceramic grade could be produced from some of the deposits by means of suitable ore-dressing treatment.

One of the better-known feldspar occurrences is the feldspar stock at Copper Mountain, described by Dolmage in Geological Survey of Canada Memoir 171, 1934, on page 20. This deposit is large, its composition is homogeneous, and it is well situated with regard to transportation. The rock consists essentially of orthoclase and albite feldspar with minor amounts of iron-bearing minerals*. Two typical analyses of it are:—

	Per Cent	Per Cent
SiO_2	62.86	61.89
Al_2O_3	20.41	19.35
Fe_2O_3	0.35	1.03
FeO	0.14	0.55
MgO	0.20	0.54
CaO	1.20	1.06
Na_2O	4.87	6.07
K_2O	7.35	7.12

Analyses of samples from a pegmatite deposit near Lumby are as follows:—

	Per Cent	Per Cent	Per Cent
SiO_2	65.08	73.06	73.76
Al_2O_3	18.64	14.42	15.32
Fe (total)	0.31	0.18	0.32
CaO	0.43	0.12	1.06
Na_2O	1.64	1.57	1.43
K_2O	9.98	9.43	5.60

KYANITE

Kyanite has been noted in schists from a number of places in British Columbia, but no deposits of commercial size and grade have so far been located in the Province.

On the west side of the Columbia River, between Death and Priest Rapids, 40 miles north of Revelstoke, numerous bladed crystals of kyanite occur† in pegmatitic boulders along the river bank for over 1,000 feet. On the basis of a sample submitted to the Ore Dressing and Metallurgical Division, Ottawa, it was found‡ that a high-grade kyanite

* *See* " Notes on Magnetic Separation Tests " on page 39.
† *Minister of Mines, B.C.*, Ann. Rept., 1931, pp. 148, 149, 211.
‡ Mines Branch, Dept. of Mines, Canada, Pub. No. 736, pp. 238–240.

concentrate could be produced by flotation. Further tests by the Division of Ceramics and Road Materials, Ottawa, indicated that the flotation concentrate was of interest for the production of refractories. Kyanite-bearing rock corresponding to the above-mentioned boulders has not been found in place, although their occurrence would suggest a near-by source.

In the region of the North Thompson River, along the main line of the Canadian National Railway, kyanite has been observed over a distance of about 40 miles, from Serpentine Creek south of Lempriere Station to Mica Mountain near Tête Jaune. Outcrops containing kyanite occur west of the tracks south of Albreda, on Porter Creek, on the creek at Mile 87, and on the Canoe River half a mile above the railway bridge. Pan concentrates containing kyanite have been obtained from Serpentine, Moonbeam, Clemina, Camp, Porter, and Mica Creeks, and from Canoe and McLellan Rivers.

Kyanite is found in place either in schist or in pegmatite dykes. The mineral apparently is not restricted to any particular bed but appears to form where there is an abundance of injected pegmatitic material. The kyanite schist is a coarsely crystalline rock composed of biotite, feldspar, and brown garnet, with as much as 10 to 15 per cent kyanite. The kyanite is in grey to blue, flat tabular crystals commonly 1 inch by half an inch and sometimes as large as 6 inches by 1½ inches. The kyanite schist beds are usually from 5 to 6 feet thick, dip at an angle of from 30 to 60 degrees, and are parallel to the adjoining beds of rock. In the pegmatite the kyanite is clear and free from impurities, but in the schist it is grey and contains small garnets and dusty inclusions.

Boulders of kyanite schist are abundant in Porter Creek, 7½ miles north of Albreda. The widest exposure of the schist seen in place in this creek was a 6-foot bed about 1½ miles west of the tracks.

In 1943 the War Metals Research Board at the University of British Columbia did laboratory work on a sample of the material from Porter Creek. It was found that by flotation a high-quality kyanite concentrate could be obtained that represented 17 per cent, by weight, of the feed. A mica product suitable for use by roofing manufacturers was also obtained at the same time from the sample.

Although no deposits of minable size have been located as yet, there should be good possibilities of finding kyanite-bearing rocks of commercial grade in the above areas by careful prospecting.

NEPHELINE SYENITE

In Geological Survey of Canada Memoir 38, 1912, on page 448, Daly describes a large body of nepheline syenite by the Richter Pass Highway a few miles west of Osoyoos. The results of an analysis of a sample of the crude rock from this deposit are as follows:—

	Per Cent		Per Cent
SiO_2	62.00	MgO	0.50
$Fe_2O_3+TiO_2$	3.15	K_2O	5.70
Al_2O_3	18.84	Na_2O	5.00
CaO	5.06		

Part of the sample crushed to —20 mesh and passed through a magnetic separator* gave the following analysis:—

	Per Cent		Per Cent
SiO_2	65.16	MgO	Trace
$Fe_2O_3+TiO_2$	0.23	K_2O	6.00
Al_2O_3	20.09	Na_2O	5.00
CaO	3.60		

Another nepheline syenite deposit is described by Allen in Geological Survey of Canada Memoir 55, 1914, on pages 121 to 158. As this lies partly or wholly in Kootenay National Park, it can be of no commercial interest.

* *See* "Notes on Magnetic Separation Tests" on page 39.

PYROPHYLLITE

Two deposits of pyrophyllite are known in British Columbia.

Kyuquot (50° 127° S.E.) The largest deposit of pyrophyllite is on Kyuquot Sound, a large inlet on the west coast of Vancouver Island, about 200 miles north of Victoria. The closest permanent settlement is the fishing village of Kyuquot, about 15 miles from the deposit. There is regular steamship service between Victoria and Kyuquot.

At least four separate bodies of pyrophyllite occur at this deposit, and all are within a few feet of tide-water, except for one that is about 2,000 feet inland.

The occurrence has been known for over forty years and has been reported on by Clapp* and Spence†.

Around 1910 some pyrophyllite was mined for use as refractory material for the British Columbia Pottery Company in Victoria, and a small amount was also used for the manufacture of cleansers and soaps. In 1941 a 5-ton shipment was taken to Vancouver for investigation as to its suitability for paper filler. The colour was good, but the material was difficult to grind.

A report of ceramic tests carried out on this pyrophyllite in the Department of Mines Laboratory, Ottawa, states:‡ " It burns steel hard at cone 1 and shows good refractoriness." Work in the Ceramic Department of the University of Saskatchewan in 1929§ indicated that the material " was found to burn white with a few dark specks, and to have a fusion point of cone 27. It was considered to have merit for whiteware bodies and also, possibly, for general industrial use, though for refractories the fusion point was low."

The pyrophyllite deposits occur as well-defined somewhat irregular masses, representing replacement of volcanic rocks near contacts with intrusive diorite and quartz diorite. The volcanics are chiefly porphyritic and fragmental andesites and dacites of Triassic and Lower Jurassic age.

The pyrophyllite rock is massive in form and consists essentially of pyrophyllite ranging in amount from 50 to 90 per cent, with the remainder composed of fine-grained quartz and a little sericite.

The weathered surface of the pyrophyllite bodies is marked by a hard siliceous capping, commonly iron stained, to a depth of several feet. Below this the rock becomes relatively soft and free from stains.

Estimates place the combined tonnage of all the deposits as greater than half a million tons.

An analysis of fairly representative material from the Deertrail claim|| is as follows:—

	Per Cent		Per Cent
SiO_2	71.88	Na_2O	0.36
Al_2O_3	23.56	K_2O	0.43
Fe_2O_3	0.14	H_2O (+105° C.)	3.24

Semlin (50° 121° N.E.) Mountain Minerals Ltd., of Lethbridge, Alta., has done some work on another pyrophyllite deposit half a mile south of Semlin, a station on the Canadian Pacific Railway about 10 miles east of Ashcroft. The deposit occurs as an irregular band in volcanics. On the footwall side of the band the volcanics are somewhat silicified. In strike the band follows the general jointing and sheeting in the volcanics. It has been exposed by open-cuts over a length of several hundred feet and a maximum width of 15 to 20 feet. The surface material in the cuts is quite heavily iron stained. The staining may possibly decrease with depth, but sufficient work has not been done to establish this point. There appears to be a tendency

* *Geol. Surv., Canada,* Sum. Rept., 1913, pp. 109–126.
† Mines Branch Pub. No. 803, Dept. of Mines, Ottawa, pp. 131–135.
‡ *Geol. Surv., Canada,* Mem. 24E, pp. 148–150 (1912).
§ Mines Branch Pub. No. 803, Dept. of Mines, Ottawa, p. 135.
|| Mines Branch Pub. No. 803, Dept. of Mines, Ottawa, p. 134.

for the typical soft material at the surface to become harder and more siliceous with depth, but here again more work is needed for confirmation.

In 1948 the company sent a bulk sample to the Bureau of Mines at Ottawa for grinding tests. The conclusions reached as a result of the test are as follows:* "The material as received contained a large percentage of discoloured material which, if not removed prior to grinding, would result in an off-colour product.

"Tests made on the portion of the sample remaining after removal of as much as possible of the discoloured material indicated that a product suitable for ceramic or filler use can be obtained."

In 1950 a shipment of 90 tons of the pyrophyllite was made for testing.

SILICA

Silica occurs as quartz veins and quartzites in various places in British Columbia,† but as yet no silica sand has been found. Work in the British Columbia Department of Mines Laboratory has indicated‡ that by means of magnetic separation and table agglomeration, local sands can be treated to yield a product of the following analysis:—

	Per Cent		Per Cent
SiO_2	96–98	Fe_2O_3	0.50–0.08
Al_2O_3	1.5–2		

Production of silica in the Province to date has been mainly for flux for the smelter at Trail, with a minor amount for stucco dash.

SYENITE

Brief notes on magnetic separation tests made on syenite from three localities appear below.

TALC

Talc deposits are widespread in British Columbia,§ some of the better-known ones being at Keefers (50° 121° S.W.); Wolfe Creek (48° 123° S.W.), southern Vancouver Island; Anderson Lake (50° 122° N.E.); Mount Whymper (51° 116° S.W.); Redearth Pass (51° 116° S.W.); and Jessica (49° 121° S.E.), 17 miles northeast of Hope.

In general, the talc is dark when powdered and thus is unsuited to most uses. Between 1917 and 1935 a small quantity was mined from the Anderson Lake and Wolfe Creek deposits for use in dusting asphalt-roofing materials. In 1932 the Jessica deposit was investigated as a possible source of soapstone blocks for alkali-recovery furnaces in kraft-mills. The material was tested and the results were favourable, but no further development ensued. During the last war, Wartime Metals Corporation produced a small quantity of lava talc from the Redearth Pass deposit, but there has been no further production.

NOTES ON MAGNETIC SEPARATION TESTS

Magnetic separation tests were made in the laboratory of the British Columbia Research Council under the direction of Mr. Cummings, the procedure being: Samples were crushed and ground to minus 20 mesh plus 100 mesh and passed over the Dings High-Intensity magnetic separator set for maximum removal of iron-bearing impurities. The resulting non-magnetic products were submitted to Victoria for analysis along with head samples.

* Mineral Dressing and Metallurgical Laboratory Report No. 2435.—Grinding Tests on a Sample of Pyrophyllite from Semlin, British Columbia, Bureau of Mines, Ottawa, June 10, 1948.

† Mines Branch Pub. No. 686, Dept. of Mines, Ottawa, pp. 6, 7, 37–41.
Minister of Mines, B.C., Ann. Rept., 1947, p. 222.

‡ Preliminary Investigations into Possibilities for Producing Silica Sand from British Columbia Sand Deposits, J. M. Cummings, 1941.

§ Mines Branch Pub. No. 583, Dept. of Mines, Ottawa, pp. 18–23.
Geol. Surv., Canada, Ec. Geol. Series No. 2, pp. 33–52.
Mines Branch Pub. No. 803, Dept. of Mines, Ottawa, pp. 53–62.

The materials on which magnetic separation tests were made were from the following deposits:—

Feldspar: Copper Mountain stock as described by Dolmage, *see* page 36 of this report.

Nepheline syenite: Nepheline syenite intrusives on Richter Pass near Osoyoos, described by Daly in Memoir 38, *see* page 37 of this report.

Syenite: (1) Highway about 5 miles east of Princeton on way to Hedley (old road); (2) highway along west side of Long Lake a few miles south of Vernon; (3) small stock on north side of Bull River, East Kootenay, about 3 miles upstream from railway.

None of the tests yielded a "non-magnetic" fraction with an iron oxide content of the order of 0.10 per cent or less, as required for ceramic use. It may be, however, that finer grinding, or other variations in procedure, would permit more complete removal of iron from some of the materials tested.

APPENDIX A.—NOTES ON INDUSTRIAL USES OF CLAYS AND SHALES

This appendix contains brief notes on the more important kinds of clay and shale and on their industrial uses. A mimeographed publication entitled " Notes on the Properties and Uses of Clays and on the Origin of Clay Deposits," by J. M. Cummings, can be obtained by writing to the British Columbia Department of Mines. This publication contains detailed information on the nature, origin, and processing of clay and shale.

Clays are naturally occurring earthy materials which are more or less plastic when wet, and in that condition they can be moulded to a definite shape that is retained after drying. They can also be converted to a hard stony substance by the application of heat, a process called firing or burning. A shale is a clay that has become compacted into a solid rock. A shale that has been allowed to weather, or has been ground finely, becomes a clay again and may be suitable for manufacture into clay products.

CHINA-CLAY (KAOLIN)

This clay consists mainly of the mineral kaolinite. There are no known deposits in British Columbia, and no kaolin is at present produced in Canada.

The paper industry is the largest single consumer of china-clay, using it as a filler and as a coating agent. Filler clays must be white, have a high brightness factor, be relatively free from grit, and must meet requirements in respect to retention and opacity. Coating clays must meet similar but more exacting specifications, particularly with reference to fineness, colour, and brightness.

China-clay is one of the chief ingredients of most whiteware, such as porcelain, chinaware, wall and floor tile, sanitary ware, and electrical porcelain. It is also used extensively in the manufacture of certain refractories, cements, and art pottery. Other uses for china-clay are as filler in cotton goods, oilcloth, paints, and cosmetics.

In general, china-clay is characterized by high refractoriness, relatively low plasticity, and white colour after burning.

BALL CLAY

Ball clays are white to cream burning, highly plastic clays. They are composed essentially of very fine particles of kaolinite with minor amounts of such minerals as halloysite or montmorillonite. Ball clay is less refractory than china-clay and vitrifies at a lower temperature. The Giscome clay deposit of British Columbia is in between a ball and china clay.

Ball clays are used in the ceramic industry to impart plasticity and dry strength to the less plastic batches used for the manufacture of various whitewares, crucibles, refractories, and grinding-wheels.

SLIP CLAY

Slip clays melt to a brown or green glass at relatively low temperatures. They are used for glazing certain ceramic wares and as a binder in the manufacture of some abrasive products.

FIRECLAY

The term " fireclay " is applied to any shale or clay that is suitable for the manufacture of heat-resistant or refractory products. True refractory clays are infusible at temperatures below 3,000 degrees Fahrenheit (cone 29), but clays with fusion points as low as 2,700 degrees Fahrenheit (cone 19) are commonly referred to as " low heat duty fireclays." Chemically, the fireclays are high in silica and alumina and very low in iron, lime, magnesia, and alkalis.

The only known fireclay deposits of commercial value in British Columbia are found on Sumas Mountain.

Most fireclay is used for the manufacture of refractories, the remainder is used in making stoneware, terra cotta, and heavy clay products.

MISCELLANEOUS CLAYS AND THEIR PRODUCTS

Stoneware.—Stoneware is generally made from plastic refractory or semi-refractory clays of low shrinkage and long firing range. They can be burned to a dense cream- to tan-coloured body at a relatively low temperature. The Big Bend deposit north of Quesnel is an example of this type of clay.

Terra Cotta.—Terra cotta is made from materials similar to those used for stoneware, but lower density of final body is permissible and firing temperature may be lower.

Sewer-pipe.—Sewer-pipe is made from relatively plastic clay or shale which moulds well, does not crack on drying or burning, and is sufficiently siliceous to take a salt glaze. Some of the Sumas Mountain shales make good sewer-pipe. Sewer-pipe was made from shales obtained from the Extension and Cumberland coal mines.

Facebrick.—Facebrick requires clays that give uniform and pleasing colour, adequate hardness, and low absorption when fired at a relatively low heat. Some of the Sumas Mountain shales are used for facebrick.

Common Brick and Hollow Tile.—These can be made from almost any clay that is reasonably plastic and will burn hard at low temperatures without cracking or bloating. Most common brick clays fire to shades of red or reddish brown.

Cement.—A considerable amount of common clay is used to provide silica and alumina in the manufacture of portland cement.

Light-weight Aggregate.—Light-weight porous materials such as pumice and cinders have long been used as a substitute for gravel in making light-weight concrete. In 1920 a plant was built in the United States to manufacture from shale an artificial porous rock material for use as a light-weight aggregate. This was the beginning of the "bloated" or "expanded" shale industry in America. With the great advances in the building industry and recent building booms, the demand for light-weight aggregates has increased enormously, and to-day the production of expanded shale aggregate has become an important industry in the United States. Although the use of light-weight aggregate is not unknown in Canada, it is relatively unfamiliar to most people. At present the only operating shale-bloating plant in Canada is in Cooksville, Ont. This plant has operated since 1927.

To make expanded shale aggregate, a suitable raw shale is crushed to a size somewhat smaller than the desired product. The crushed shale is then heated in a furnace or kiln. At the critical temperature the shale is in the pyroplastic state and gases that form internally expand the mass to form a porous pumice-like material. Quick cooling freezes the semi-molten rock about the pores and the cellular structure is retained in the final product. The material thus produced is known as expanded or bloated shale.

Most clays, shales, and even slates will bloat to some degree. However, only a few can be used commercially. To be of economic value at present, a shale must form a satisfactory cellular material at a temperature somewhere between 1,800 degrees Fahrenheit and 2,400 degrees Fahrenheit, preferably about 2,000 degrees Fahrenheit. Although much research is being done on shale bloating, there is at present no known satisfactory means of recognizing a good bloating shale either from appearance or chemical composition. The only sure way of finding out whether or not the unknown material will bloat is to have a test sample run through a kiln.

Many clays can be worked into a plastic mass and extruded to form pellets that will bloat to make very satisfactory aggregate. However, the added expense of fabrication and extra heat required for drying increases substantially the final cost of the aggregate produced.

A few shale samples from the Vancouver and Victoria areas have been tested for expansibility, but none has proved satisfactory.

APPENDIX B.—GENERAL NOTE ON CLAY TESTING

The procedures used in testing and explanations of items listed in the test results shown in various tables throughout this report are summarized briefly in the following paragraphs.

LABORATORY TESTING OF CLAYS

The testing of clays for ceramic purposes is a specialized field involving the following general procedure:—

The sample is examined for texture, content of grit and pebbles, and tested with acid to determine presence or absence of calcium carbonate.

Some of the sample is ground and mixed with water until the best workability is obtained. Working qualities are judged and the weight of water is recorded. Plastic clay is moulded into briquettes which are dried and fired at various temperatures, the drying behaviour and shrinkage being noted. The fired briquettes are examined for hardness, texture, soundness, and colour, and the shrinkage and water absorption are measured.

Some of the sample is ground through 60 mesh and after moistening is moulded into a so-called cone of standard shape and size. After drying, the test cone is mounted on a plaque in company with a series of standard cones of similar dimensions, the composition of which is so adjusted that they fuse at definite known temperatures. The group is then fired in a furnace under neutral or oxidizing conditions, the rate of temperature increase being carefully controlled within specified limits, and the plaque being observed at frequent intervals to note progress of the test. The fusion point of a cone is arbitrarily taken to be the point at which the tip of the cone bends over and touches the base on which it is mounted. By observing the condition of the standard cones at the fusion point of the test cone, the fusion point or so-called pyrometric cone equivalent (P.C.E.) of the unknown sample is obtained. The standard cones are numbered in order of ascending refractoriness, and the fusion point of the test sample is recorded as a number, the number representing that of the standard cone which had most nearly reached its end point simultaneously with the unknown. In general, the cone series ascends in refractoriness from cone 022 through cone 1 to cone 42. The following examples illustrate approximate temperatures corresponding to typical end points of selected cones fired under specified conditions.

Cone	Degrees Fahrenheit	Degrees Centigrade
022	1085	585
010	1634	890
04	1922	1050
1	2057	1125
10	2300	1260
20	2768	1520
30	3002	1650
34	3200	1760

From the results obtained in the tests that have been outlined, a skilled investigator can usually decide the suitability of a clay for ceramic purposes. Other tests, sometimes made as part of preliminary investigations, include determination of dry strength, grain size distribution, and even chemical composition, although chemical analysis is not particularly informative in the case of most clays.

Methods of testing clays for other than ceramic uses differ for each case in question and hence are too complex for complete discussion here. Specifications or tests have been set up for some applications, while for others the judgment of, or plant trials by, potential consumers is the only means of checking the value of a clay.

Paper-filler clays are required to be white in colour, to be of a certain degree of fineness (usually at least 95 per cent —200 mesh), and to meet required standards in regard to retention. Coating clays must be of even higher whiteness and brilliance.

Bond clays for foundry sands are checked according to a regular procedure accepted by the foundry industry.

The decolorizing powder of bleaching earths is determined by comparison with standard materials.

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TABLE III.—BRITISH COLUMBIA CLAY DEPOSITS

Map No.	Location	Description	Workability	Drying Characteristics	Firing Characteristics: Cone	Absorption	Shrinkage	Colour	Miscellaneous	Remarks
						Per Cent	Per Cent			
2	Gilford Island—at Port Elizabeth in a cove on south shore of harbour	Bluish compact stratified clay	Tenacious habit when wet							Ref.: G.S.C. Mem. 23, 1913, pp. 122, 144. Probably suitable for brick and tile.
3	Loughborough Inlet — stream bed west of Bay Post-office	Clay as No. 2								As for No. 2.
4	Maurelle Island — south side 1½ miles above Surge Narrows	About 20 feet above sea-level, covered by a few feet of sand; clay as No. 2								As for No. 2.
5	Reede Island—near shore-line	As for No. 2								As for No. 2. SiO_2, 60.86; Al_2O_3, 16.64; Fe_2O_3, 7.34; CaO, 5.72; MgO, 3.30; K_2O, 2.73; Na_2O, 3.55; water (total), 2.35.
6	South Valdes Island at Open Bay	As for No. 2								As for No. 2.
7	Texada Island—Crescent Bay and 2 miles north of Gillies Bay	Glacial clay, very gritty, slightly calcareous	Fairly good plasticity	Av. shrinkage, 8 per cent	010 06 03	16 15 4	0.0 — —	Light red Red Dark red	Hard. Steel hard. Almost vitrified.	Ref.: G.S.C. Mem. 58, 1914, p. 99. Good common brick clay.
10	Union Bay to Bowser	Dark-grey non-calcareous clay	23.6 per cent water; works well, fairly plastic	Safe drying, 85° C.; av. shrinkage, 6.4 per cent	06 02 1	14.3 6.9 3.6	0.6 4.2 6.0	Light red Dark red Dark red	Fairly soft. Hard. Very hard.	P.C.E.=4.5. Good drying and sufficient plasticity for modelling and moulding. Adequate firing range for pottery but dark colour.
12	Alberni Canal — Roger Creek	Glacial clay of large extent, yellowish, tough, and silty						Red	Low fusion point.	Ref.: G.S.C. Sum. Rept., 1922, Pt. A, p. 61A. SiO_2, 56.8; Al_2O_3, 17.5; Fe_2O_3, 10.8; CaO, 3.1; MgO, 0.3; Ig. loss, 6.8.
12	Smiths Landing—25 miles down Canal	Large deposit, clay free of stones								SiO_2, 57.5; Al_2O_3, 20.2; Fe_2O_3, 9.2; CaO, 7.0; MgO, 3.2; Ig. loss, 2.9. Conveniently located.
17	Nanaimo area	Glacial and Puyallup interglacial clays	Sandy, weak, and poor plasticity					Red		Ref.: G.S.C. Mem. 51, 1914, p. 121. B.C.M.M. 1908, p. 185. Used for brick before 1908.

						Per Cent	Per Cent			
18	Southeast of Ladysmith	Puyallup interglacial surface clay, yellow-grey, and sandy	Fairly plastic	Moderate shrinkage				Red	Low fusibility, burns hard at low temperature.	Ref.: G.S.C. Mem. 96, 1917, p. 397. Suitable for brick, drain-tile, and portland cement.
19	Somenos—8 miles north of Duncan	*Glacial clay*								Ref.: B.C.M.M. 1908, p. *185. SiO_2, 67.6; Al_2O_3,* 13.6; Fe_2O_3, 8.8; CaO, 3.6; MgO, 0.2; Ig. loss, 5.6.
20	Duncan area	Puyallup interglacial clay, yellow to blue-grey, sandy with pebbles	Fairly plastic	Moderate shrinkage				Red	Low fusibility, burns hard at low temperature.	Ref.: G.S.C. Mem. 96, 1917, pp. 341, 397. SiO_2, 67.6; Al_2O_3, 13.6; Fe_2O_3, 8.8; CaO, 3.6; *MgO, 0.2; Ig. loss, 5.6.* Suitable for common brick, drain-tile, and portland cement. *Has* been used for brick at Somenos.
24	Saanichton — Bazan Bay Brick & Tile Company Limited	Light-buff clay, non-cal*careous*	31.5 per cent water; is plastic and works well	Slight cracking on fast drying at 85° C.; shrinkage, 9.0 per cent	08	15.4	1.7	Dark salmon	Fairly hard, slight cracking.	P.C.E.=4. Used for brick and tile at present.
					06	14.0	2.6	Dark salmon.	*Fairly hard, slight* cracking.	
					04	11.7	3.1	Salmon red	Fairly hard, some cracking.	
					02	2.5	7.8	Dark red	Steel hard, some cracking.	
					1	0.2	8.7	Dark brown	Steel hard, some cracking.	
25	Sidney Island	Glacial clay								Ref.: G.S.C. *Mem. 24E,* 1912, p. 143. Has been used for common brick.
26	Tod Inlet, South Saanich, 60 feet above sea-level	15 feet of fairly uniform *sandy clay, a few peb*bles and boulders								SiO_2, 65; Fe_2O_3, 14; Al_2O_3, 10; CaO, 5; MgO, 1.1. Used in making portland cement.
27	Esquimalt—Atkin's lot									Ref.: G.S.C. Mem. 36, *1913, p. 109. P.C.E.=3.* SiO_2, 63.6; Al_2O_3, 19.0; Fe_2O_3, 7.6; CaO, 3.6; MgO, 0.2; water, *6.0.*
28	Victoria—*Baker Brick &* Tile Company Limited	*Glacial,* tough, gritty, greyish-white, slightly calcareous with some *organic matter*	28 per cent water; is good working, and moderately plastic	Cracked drying at 80° C. but healed to hair cracks; av. shrinkage, 7.4 per cent	08	15.0	0.0	Dark salmon	Fairly hard, slight *scum.*	P.C.E.=3. Used for building-tile, interlocking tile, drain-tile, and flower-pots.
					06	13.5	0.3	Dark salmon	Hard, slight scum.	
					04	13.0	2.0	Salmon red	Hard, slight scum.	
					02	3.9	7.0	Dark red	*Steel hard, slight* scum.	
					1	*0.2*	8.9	Brown	Steel hard.	
29	Entrance Sooke Harbour	Sandy clay with carbonaceous particles, 30 feet thick								

TABLE III.—BRITISH COLUMBIA CLAY DEPOSITS—*Continued*

Map No.	Location	Description	Workability	Drying Characteristics	Firing Characteristics: Cone	Absorption	Shrinkage	Colour	Miscellaneous	Remarks
						Per Cent	Per Cent			
30	Heads of bays on south shore of Gambier Island	Boulder clay, rather pure and compact			—	—	—			
31	Anvil Island	Reworked glacial clay, stratified, hard, tough, silty, yellow-blue and blue-grey	Good plasticity, much fine grit and some pebbles	Shrinkage, 6 per cent; tensile strength, 283 p.s.i.	010	16.74	0.35	Red		Ref.: G.S.C. Mem. 24E, 1912, p. 142. B.C.M.M. 1908, p. 186. P.C.E.=2. SiO_2, 58.6; Al_2O_3, 26.7; Fe_2O_3, 7.5; CaO, 4.0; MgO, tr.; Ig. loss, 3.0.
					03	7.76	3.0	Red		
					1	—	—		Fused.	
32	Northeast shore, head of Howe Sound	Boulder clay, rather pure and compact			—	—	—			Ref.: G.S.C. Mem. 24E, 1912, p. 150; G.S.C. No. 996, 1908, p. 26. SiO_2, 60.6; Al_2O_3, 24.0; Fe_2O_3, 7.6; CaO, 1.0; MgO, 0.3; Ig. loss, 7.0.
33	Capilano valley, 1½ miles above suspension bridge	Well-stratified glacial-lake deposit			—	—	—			Ref.: G.S.C. No. 996, 1908, p. 26.
34	Lynn Creek—5 miles north of North Vancouver	Light-grey non-calcareous glacial-lake deposit, some pebbles	25 per cent water; works fairly well, fair plasticity, tendency to be flabby	Dries safely at 85° C.; av. shrinkage, 4.9 per cent	06	16.0	0.0	Salmon	Soft.	P.C.E.=5. Suitable for common brick and tile.
					03	9.1	3.8	Dark salmon	Fairly hard, some scum.	
					01	2.7	7.6	Brown-red	Very hard.	
					2	0.0	9.7	Dark brown-red	Vitrified, no scum.	
40	Pleasantside—Pacific Clay Products Limited	Buff non-calcareous surface clay	25.7 per cent water; gives poor, very flabby silt-like material; workability poor	Dries safely at 85° C.; av. shrinkage, 5.7 per cent	06	16.8	0.2	Dark salmon	Soft.	P.C.E.=4½. Is used for facebrick. Fired colours good, moderate to short firing range.
					04	16.0	0.3	Salmon red	Fairly soft.	
					02	10.8	3.0	Dark red	Hard.	
					01	9.1	3.7	Dark red	Hard.	
					1	1.7	7.7	Dark red-brown	Steel hard.	
					3	0.1	8.6	Dark brown	Steel hard.	
41	Port Moody — Burrard Brick and Tile Company	Blue clay similar to Haney			—	—	—			
42	Lulu Island	Surface clay, grey, silty, non-calcareous	Rather flabby body	Safe fast drying, low shrinkage	—	—	—			Ref.: G.S.C. Mem. 135, 1923, p. 38. Bricks burn pale red. Punky body at 1,650° F. and too soft, porous at 1,750° F. and still soft. Burned colour good but scummed. Makes porous water-jugs.
43	East New Westminster near Queens Park—Coughlan and Sons Company	Glacial clay			—	—	—			Ref.: B.C.M.M. 1908, p. 185.

						Per Cent	Per Cent			
45	South side of Fraser River, 2 miles southwest of New *Westminster* — Fraser River Brick and Tile Co. Limited	Clay 15 feet thick, but thins to zero to eastward	......	......	......	......	......	......	......	Ref.: G.S.C. Mem. 24E, 1912, p. 140.
46	1½ miles above New Westminster on south side of Fraser River	6 to 10 feet of stratified clay overlain by gravel	......	......	......	......	......	......	......	Ref.: G.S.C. Mem. 135, 1923, p. 38.
47	Bear Creek, Surrey—Victoria Tile & Brick Supply Co. Ltd.	Yellow-grey non-calcareous clay	28 per cent water; works well, good plasticity	Safe drying at 85° C.; av. shrinkage, 9.3 per cent	08	17.5	0.3	Salmon red	Fairly hard.	P.C.E.=4. Good clay with long firing range, good plasticity and good colour. Plant producing common brick.
					06	15.2	1.4	Dark salmon red	Fairly hard.	
					04	14.1	2.1	Bright red	Hard.	
					02	4.5	6.5	Dark red	Steel hard.	
					1	0.1	9.0	Brown	Steel hard, some warping.	
48	Sullivan	Grey-buff soft clay	29 per cent water; is plastic and works well	Safe drying; av. shrinkage, 8.1 per cent	08	17.3	0.6	Salmon	Fairly hard.	Considered suitable for common brick, hollow tile, and drain-tile.
					06	15.3	1.7	Dark salmon	Hard.	
					03	10.6	3.0	Dark salmon	Very hard.	
49	Surrey, 1 mile north of Cloverdale — Surrey Brick and Tile Company Limited	Top bed of buff soft clay	29 per cent water; plastic, and works well	Safe drying; av. shrinkage, 7.6 per cent	08	18.6	0.3	Light salmon	Fairly hard.	P.C.E.=2. Suitable for common brick and tile.
					06	16.6	1.3	Salmon	Hard.	
					03	6.9	4.6	Dark salmon	Hard.	
		5 feet of blue clay under above	28 per cent water; plastic, and works well	Tendency to crack on drying; av. shrinkage, 7.6 per cent	08	18.5	0.3	Light salmon	Fairly hard.	P.C.E.=2. Tendency to crack but could be obviated by slow drying and use of sand. Useful for common brick and tile.
					06	17.5	1.0	Salmon	Hard.	
					03	12.0	4.0	Brown-salmon	Hard.	
50	Port Haney—Port Haney Brick Company Limited	Grey non-calcareous surface clay	46.2 per cent water; fine grained, very plastic but sticky, works fairly well	Cracked badly on fast drying at 85° C.; av. shrinkage, 11.7 per cent	010	17.4	2.0	Salmon	Fairly hard.	Ref.: B.C.M.M. 1908, p. 186. P. C. E. = 01½. SiO_2, 58.5; Al_2O_3, 21.1; Fe_2O_3, 8.6; CaO, 6.5; MgO, 0.5; Ig. loss, 4.8. Used for brick and tile.
					08	15.0	2.8	Salmon	Fairly hard.	
					06	9.7	5.7	Salmon red	Hard.	
					04	0.6	9.7	Brown-red	Steel hard.	
					02	0.1	9.5	Dark brown-red	Steel hard.	
52	Ruskin — Heaps Brick Company Limited	5 to 8 feet of grey clay on top of blue clay	31.8 per cent water; is fairly plastic	Bricks checked some on rapid drying; av. shrinkage, 6.6 per cent; tensile strength, 138 p.s.i.	010	21.7	1.7	......	Burned to good red colour and hard body at 010.	Ref.: G.S.C. Mem. 47, 1914, p. 54. Good all-round clay for common brick and tile.
					05	15.2	3.0	......		
					03	12.5	6.0	......		
					1	4.9	9.6	......		
					3	......	......	......	Nearly fused.	
53	Silverdale—south side of Fraser River on C.N.R.	Laminated grey clay	Very plastic	Av. shrinkage, 7 per cent; tensile strength, 183 p.s.i.	010	16.2	0.0	......	Burns red-brown with good body at 010.	Ref.: G.S.C. Sum. Rept., 1913, p. 232; G.S.C. Mem. 47, 1914, p. 54. Good for dry-press brick and drain-tile.
					05	15.5	0.3	......		
					1	12.4	1.6	......		
					3	......	......	......	Nearly fused.	
54	Hazel Brae—Clayburn	Surface clay	30 per cent water; very plastic	Dried well without warping; av. shrinkage, 6 per cent	08	16.0	1.0	Red	......	Ref.: G.S.C. Mem. 24E, 1912, p. 141; Mem. 25, 1913, p. 98.
					05	16.4	1.0	Red	......	
					1	......	......	......	Past vitrification.	
55	Clayburn	Blue-grey clay	......	......	......	......	......	......	......	Ref.: G.S.C. Mem. 24E, 1912, p. 126. Used for common brick.

TABLE III.—BRITISH COLUMBIA CLAY DEPOSITS—*Continued*

Map No.	Location	Description	Workability	Drying Characteristics	Firing Characteristics: Cone	Absorption	Shrinkage	Colour	Miscellaneous	Remarks
						Per Cent	Per Cent			
62	Lillooet—1 mile west on road to Seton Lake	Green-grey bedded silt of glacial "white silt" formation 18 feet thick sampled	Short in texture	Av. shrinkage, 5 per cent	010	18.0	....	....	Burns to light-red porous body.	Ref.: G.S.C. Mem. 118, 1920, p. 72. Makes good common brick by soft-mud process. Many large deposits along Fraser as far as Quesnel.
					03	17.0	7.0	....		
63	Thompson River, Ashcroft to Kamloops	Clay silt formation of "white silts"	....	....	....	....	....	....	....	Ref.: G.S.C. Sum. Rept., 1912, p. 146. Suitable for common brick.
64	Kamloops—Johnston and Company Limited, 2½ miles west of town on terrace	Weathered portion of hard laminated silty clay; calcareous with much fine grit and mica	23 per cent water; moderately plastic	Av. shrinkage, 4.6 per cent; tensile strength, 156 p.s.i.; stands rapid drying	010	19.12	....	Red	....	Ref.: G.S.C. Mem. 24E, 1912, p. 120. Fair dry-press bricklets at cone 03 with 13.6 per cent absorption.
					03	11.74	2.0	Red	....	
64	Southwest Quarter of Section 3, Township 20, west of 6th meridian	Yellow gritty slightly calcareous clay	Stiff, waxy mass; hard to mould	Cracked badly on drying	010	....	....	....	Cracked badly on firing.	Ref.: G.S.C. Mem. 25, 1913, p. 70.
65	Westwold	Grey clay, very calcareous	32.7 per cent water; works well, very plastic	Cracked slightly on rapid drying; av. shrinkage, 7.5 per cent	03	15.0	2.5	Light red	Fairly hard, scummed.	P.C.E.=8½. Good for common brick and tile.
					1	0.0	9.6	Very dark red	Vitrified.	
66	Pillar Lake Road — 10 miles north of Falkland	Light-brown clay, very calcareous	30.8 per cent water; very plastic	Safe drying at 85° C.; av. shrinkage, 8.3 per cent	08	16.2	0.3	Dark salmon	Fairly hard.	P.C.E.=3½. Suitable for common brick and tile.
					06	16.0	0.5	Dark salmon	Fairly hard, scummed.	
					04	5.6	5.5	Dark salmon	Very hard.	
					02	2.8	6.8	Brown-red	Very hard.	
68	Enderby—Enderby Brick Company Limited	Stratified clay, yellow calcareous, with iron oxide; silty and contains many mica flakes	28 per cent water	Av. shrinkage, 6.3 per cent; tensile strength, 290 p.s.i.	010	20.7	0.0	Red	....	Ref.: G.S.C. Mem. 24E, 1912, p. 118. More refractory than most surface clays. Could be burned hard enough for use for lining sewers or underground work where non-adsorbent brick required. Too silty for stiff-mud process. Bricks were made.
					03	14.8	3.0	Red	Steel hard.	
			21 per cent water; works well	Dries safely; av. shrinkage, 5.5 per cent	1	0.23	7.3	Dark red	Vitrified.	
					5	....	....	....	Fused.	
68	Plant of Percy Gorse, of Salmon Arm, at Enderby	Light-buff non-calcareous clay	37.6 per cent water; is moderately plastic but flabby	Dries safely at 85° C.; av. shrinkage, 4.3 per cent	06	30.8	0.0	Light salmon	Very soft.	P.C.E.=2½. Firing range short and colours poor.
					02	16.5	5.6	Dark salmon red	Fairly hard.	
					01	18.2	5.5	Dark salmon red	Fairly hard.	
					1	0.5	2.45	Dark brown	Steel hard.	
					8	0.05	2.47	Dark brown	Vitrified.	

						Per Cent	Per Cent			
69	Okanagan Landing—The Lakeside Clay Products Limited	Clay deposit near the landing								Ref.: G.S.C. Sum. Rept., 1931, Pt. A, p. 99A. Some good tile made in 1920.
70	Vernon—Ebring deposit—Upper section	Light-grey very calcareous clay	45 per cent water; works fairly well, very plastic	Safe drying at 85° C.; av. shrinkage, 10 per cent	06	21.4	1.3	Dark salmon	Fairly hard, scummed.	P.C.E.=2. Suitable for common brick and tile, but a more plastic clay needed to counteract high drying and firing shrinkage.
					04	0.2	9.3	Brown-red	Vitrified, warped.	
					02	0.0	9.0	Brown-red	Vitrified, high shrinkage.	
	Lower section	Light-grey very calcareous soft clay	37 per cent water; gives poor flabby material	Safe drying at 85° C.; av. shrinkage, 5 per cent	06	26.9	0.0	Salmon	*Soft, scummed.*	P.C.E.=3. Suitable for common brick by soft-mud process.
					04	9.7	8.3	Dark salmon	Hard, warped.	
					02	7.0	7.4	Dark salmon	Hard.	
71	Kelowna	Light-yellow clay with some stones and hard dark-brown clay, non-calcareous	23.3 per cent water; works well, somewhat short	Safe drying at 80° C.; av. shrinkage, 4.6 per cent	04	16.5	1.3	Light pink	Soft, some scum.	Poor colours and scumming make clay unattractive. Abundance of iron stain due to concretions.
					2	7.5	6.0	Brown-red	Very hard, scummed.	
					8	2.9	5.8	Brown with white parts	Steel hard, almost vitrified.	
72	Quilchena — Triangle Ranch	Bentonite, 9-foot bed between coaly shales			010	14.0	0.0	Light red		Ref.: G.S.C. Mem. 25, 1913, p. 73. Strongly absorbent. No value for brick. Air shrinkage high.
					5	5.9				
					15				Not fused.	
73	Merritt	Calcareous clay, occasional scales of gypsum and much fine grit	29 per cent water; gives excellent plasticity	*Av. shrinkage, 10 per cent; adding 25 per cent sand reduces shrinkage to 8.5 per cent; tensile strength, 412 p.s.i.*	010	15.2	0.0	Light red		Ref.: G.S.C. Mem. 25, 1913, p. 75. Dry-press bricklets of clay gave excellent hard red brick at cone 05 with absorption 10.3 per cent and fire shrinkage 6.5 per cent. Very smooth and flows through annular die. 25 per cent sand desirable to avoid tearing. Could be used for common brick and drain-tile.
					05	13.0	4.5	Light red		
					03	2.2	8.0	Red		
					1				Fused.	
					010	13.8	0.3	Red	With 25 per cent sand.	
					05	8.6	2.0	Red		
76	Tulameen area — Otter Creek	Non-calcareous flood-plain silt	Fair plasticity	Av. shrinkage, 5.6 per cent	010	17.24		Red	Swells slightly.	Ref.: G.S.C. Mem. 24E, 1912, p. 123; Mem. 26, 1913, p. 181.
					03	4.5	5.8	Dark red		
					1				Fuses.	
78	Princeton area	Bentonite occurs at several spots			15				Fuses.	Ref.: G.S.C. Mem. 65, 1915, p. 27; Mem. 243, 1947, p. 131. SiO_2, 75.2; Al_2O_3, 11.39; Fe_2O_3, 1.83; carbon 0.21, 3.66.
80	Grand Forks — west of town	Light-grey calcareous clay with some organic matter	21 per cent water; is rather short and flabby	Safe drying at 85° C.; av. shrinkage, 4.8 per cent	08	17.7	0.0	Pink-buff	Soft.	P.C.E.=2. Unsuccessful attempt to use for common brick by T. A. Love Bricks Limited.
					06	17.8	0.2	Pink-buff	Soft.	
					04	18.1	0.0	Pink-buff	Fairly hard.	
					02	11.5	2.3	Dark pink-buff	Hard.	
					3	0.25	7.0	Dark brown	*Steel hard, vitrified.*	

TABLE III.—BRITISH COLUMBIA CLAY DEPOSITS—*Continued*

Map No.	Location	Description	Workability	Drying Characteristics	Firing Characteristics					Remarks
					Cone	Absorption	Shrinkage	Colour	Miscellaneous	
						Per Cent	Per Cent			
82	Nakusp—1½ miles south of town	Blue clay			—	—	—			Ref.: G.S.C. Mem. 47, 1914, p. 51. Several occurrences along Arrow Lakes.
83	Castlegar	Silty clay of lake origin			—	—	—			Was worked.
84	Nelson		28 per cent water; gives good plasticity	Av. shrinkage, 5 per cent	010	24.0	—		Slight swelling.	Ref.: G.S.C. Mem. 24E, 1912, p. 118. Good common brick clay. Has been used for brick.
					03	18.0	2.0		Burns hard but not dense red.	
					3	—	—		Fuses.	
85	Creston — along railway, best by Goat Canyon	Silty grey-yellow slightly calcareous clay	23.8 per cent water; gives fair plasticity	Av. shrinkage, 3.1 per cent; tensile strength, 25 p.s.i.	010	18.6	0.0			Ref.: G.S.C. Mem. 65, 1915, p. 33; Mem. 76, 1915, p. 156. Fit for common brick by soft-mud process.
					05	16.2	1.0			
					1	4.76	9.4			
					3	4.7	9.5			
					7	—	—		Nearly viscous.	
87	Cranbrook—Hanson Yard 2 miles west of town	St. Mary River silts; very calcareous cream-burning silt	20 per cent water; was plastic enough to flow through tile-die	Av. shrinkage, 5.4 per cent; tensile strength, 87 p.s.i.	010	26.43	0.0		Pink at low cones and red when well burned. Steel hard at 05.	Ref.: G.S.C. Mem. 65, 1915, p. 33; Mem. 76, 1915, p. 152. Wet moulded should be burned at 05 and dry press at 03. Can be used for common brick, drain-tile, flower-pots, and crude pottery.
					05	20.80	1.0			
					1	0.10	10.7			
					3	—	—		Fused.	
					010	—	—	Too soft	Dry press.	
					05	31.64	0.3	Pink		
					1	0.97	11.0	Dark brown		
89	Six Mile Creek—6 miles north of Fort Steele	Slightly calcareous, very sticky plastic clay	Flows smoothly through annular die	Must be dried slowly to prevent cracking; av. shrinkage, 4.6 per cent; tensile strength, 154 p.s.i.	010	14.6	1.6	Light red		Ref.: G.S.C. Mem. 47, 1914, p. 50. Could be used for dry-press brick and drain-tile.
					05	5.6	8.0	Dark red		
					03	1.3	8.0			
					1	0.0	7.3		Fused.	
					4	—	—			
90	Fort Steele		24 per cent water; gives low plasticity but could be moulded	Av. shrinkage, 1.3 per cent; tensile strength, 40 p.s.i.	010	31.0	—	Buff	Porous, slight swelling.	Ref.: G.S.C. Mem. 47, 1914, p. 45. Might be used for porous partition and scouring brick.
					05	30.5	—	Buff	Porous, slight swelling.	
					03	30.9	—	Buff	Porous, slight swelling.	
					1	32.0	—			
					7	—	—		Hard but porous.	
					9	—	—		Melted to glass.	
91	Elko—near road bridge	Pockets of yellow-brown clay	Plastic enough for brick; needs some sand	Av. shrinkage, 8 per cent; tensile strength, 200 p.s.i.	010	20.0	0.4	Red	Hard.	Ref.: G.S.C. Mem. 47, 1914, p. 36. Good for common brick and tile. Not enough for large plant.
					05	18.4	0.6			
					1	18.8	0.6			
					3	—	—		Vitrified.	
					5	—	—		Fused.	

						Per Cent	Per Cent			
94	Fernie—along Elk River at West Fernie	Highly calcareous light-grey clay, about 35 feet deep, half a mile wide on both banks of river for 2 miles	26.5 per cent water; is slightly flabby, fair workability	Small surface cracks on rapid drying; av. shrinkage, 6.5 per cent	03	22.0	0.7	Cream	Very soft.	Ref.: G.S.C. Mem. 25, 1913, p. 67. P.C.E.=4. Very short firing range. Has been used for common cream-coloured brick.
					1	13.5	4.5	Yellow-cream	Fairly hard.	
96	Windermere — Columbia Valley in general	*Columbia Valley silts*; very calcareous cream-coloured silty clay	*28.4 per cent water*; is flabby, has low plasticity and poor workability	*Safe in rapid drying*; av. shrinkage, 3.0 per cent	03	34.2	—1.7	Dark cream	Very soft, expanded.	Ref.: G.S.C. Mem. 47, 1914, p. 45; Mem. 25, 1913, p. 69. G.S.C. Sum. Rept., 1913, p. 231. P.C.E.=4. Porous common brick was made. SiO_2, 36.8; Fe_2O_3, 4.3; Al_2O_3, 12.4; CaO, 19.1; MgO, 4.7; Ig. loss, 20.24.
					1	31.5	—0.3	Yellow-cream	Very soft, expanded.	
97	Field — Base of Mount Stephen	Colluvial clay derived from schists and argillites on Mount Stephen; is tough and strong	20 per cent water; is somewhat plastic	Av. shrinkage, 2.7 per cent	010	22.0	0.0		Slight swelling and burned to porous body.	Ref.: G.S.C. Mem. 24E, *1912, p. 112; Mem. 55*, 1914, p. 243.
					03	20.0	0.0			
					1	16.0	0.0			
					5			Red-brown	Softened and vitrified.	
97	Yoho Valley	Yellow laminated gritty calcareous clay	Not strongly plastic and is tough and springy	Av. shrinkage, 5.0 per cent; *tensile* strength, 111 p.s.i.	010	38.0			Swelled.	Ref.: G.S.C. Mem. 24E, 1912, p. 117. Cannot be thrown on wheel but could be pressed or cast with difficulty.
					03	*38.0*			*Swelled.*	
					1				Fused.	
98	Golden—underlying river flats	Highly calcareous yellowish *silty clay; flood-plain* origin	32 per cent water; is *moderately plastic*	Av. shrinkage, 4.5 per cent; tensile strength, 50 p.s.i.	010	42.6		Buff	Slight swelling.	Ref.: G.S.C. Mem. 25, 1913, p. 69. Possible use in porous brick and cheap pottery by casting.
					05	42.6		Cream	Slight swelling.	
					03	45.2		Cream	Slight swelling.	
					1				Past vitrification.	
					2				Fused.	
99	Revelstoke—on Columbia *River near Ford River*	Grey plastic laminated *sandy clay*	Quite plastic, flowed through annular die	Cracked badly on quick drying	010	19.2	0.0		Hard.	Ref.: G.S.C. Mem. 47, 1914, p. 49.
					05	13.2	2.3		Steel hard.	
					03	9.3	5.0	Red-brown		
					1	4.7	7.7			
					4				Viscous.	
103	Alexandria district—Lepetich farm, west side of Fraser River	Light-brown very calcareous surface clay	35.9 per cent water to work	Safe drying at 85° C.; av. shrinkage, 7 per cent	06	22.5	0.2	Dark salmon	Soft.	P.C.E.=2½. Suitable for common brick and tile.
					04	17.6	2.5	Light red	Fairly soft.	
					02	7.7	5.2	Good red	Very hard.	
104	Quesnel—old brickyard on west bank of Quesnel River	17-foot bed of grey clay of Fraser River Tertiary formation	33 per cent water; plasticity and working qualities good	Dries easily but shrinkage high	010			Pale red	Hard.	Ref.: G.S.C. Mem. 118, 1920, pp. 73–74. Brick was made from this clay.
					01				Vitrified.	
104	Old P.G.E. right-of-way, half a mile north of town	Tough light-brown non-calcareous clay	39.5 per cent water; is very plastic and works well	*Cracks drying at 85°* C.; av. shrinkage, 9.7 per cent	08	21.5	0.3	Cream-buff	Fairly hard.	P.C.E.=19. Cracked on drying, high shrinkage indicates a bentonitic clay. Two other samples similar.
					06	18.2	1.7	Cream-buff	Fairly hard.	
					02	1.1	8.0	Salmon	Steel hard.	
105	*Big Bend*—east bank of Fraser River	*10- to 20-foot bed under*lying diatomite; grey-white bedded soft clay	*25 per cent water*; is plastic and works well	Dries well; av. shrinkage, 5.3 per cent	03	18.8	0.0	White	Fairly hard.	Ref.: G.S.C. Mem. 118, 1920, p. 71. P.C.E.= 17 to 19. Gives strong porous white body. Good stoneware clay.
					3	17.6	0.4	White	Hard.	
					10	16.3	0.6	White	Hard.	

TABLE III.—BRITISH COLUMBIA CLAY DEPOSITS—*Continued*

Map No.	Location	Description	Workability	Drying Characteristics	Firing Characteristics: Cone	Absorption	Shrinkage	Colour	Miscellaneous	Remarks
						Per Cent	Per Cent			
106	White's Landing — Lot 4884 on east bank of Fraser River	Calcareous clay exposed for 75 feet along bank 50 feet above river	31 per cent water; is fairly workable	Dries safely; av. shrinkage, 9 per cent	010	13.8	2.5	Salmon	Hard.	Ref.: P.G.E. Survey, Vol. 2, Pt. 2. Could be used for common wares but needs some non-plastic mix.
					06	9.9	4.5	Salmon	Hard.	
					03	3.7	9.3	Red-brown	Very hard.	
107	Woodpecker—east bank of Fraser River one-quarter of a mile south of Woodpecker	Calcareous clay 25 feet thick from water-level; exposed 500-foot length	29 per cent water; works well	Dries safely; av. shrinkage, 5.3 per cent	010	21.6	1.0	Salmon	Hard.	Ref.: P.G.E. Survey, Vol. 2, Pt. 2. P.C.E.=3½. Could be used for common brick and tile, poor colour.
					06	18.9	2.5	Salmon	Hard.	
					03	13.5	4.7	Salmon	Hard.	
108	Prince George area—old brickyard	Light-brown sandy soft non-calcareous clay	26 per cent water; plastic and works well	Dries safely; av. shrinkage, 6.8 per cent	08	18.1	0.4	Light salmon	Fairly hard.	P.C.E.=1½. Suitable for common brick and tile.
					06	16.4	1.6	Salmon	Hard.	
					03	2.8	7.0	Salmon	Very hard.	
			35.4 per cent water; fair plasticity	Cracks slightly at 85° C.; av. shrinkage, 7.3 per cent	06	18.5	1.3	Dark salmon	Fairly soft.	P.C.E.=3½. Suitable for brick and tile by stiff-mud process.
					04	7.8	7.5	Red	Hard.	
					02	0.0	11.5	Dark red	Vitrified.	
	Airport hill on highway	Light-brown calcareous clay	29.7 per cent water; poor workability, short and flabby	Safe drying at 85° C.; av. shrinkage, 5.3 per cent	06	21.4	0.0	Light red	Very soft.	Suitable for common brick by soft-mud process.
					04	17.5	1.7	Brown-red	Fairly soft.	
					02	14.1	3.7	Brown-red	Hard.	
110	Nechako — on C.N.R. 13 miles west of Prince George	Nearly white non-calcareous clay	45.3 per cent water: good plasticity and works well	Cracks at 85° C. but safe in air; av. shrinkage, 9.0 per cent	08	23.0	1.0	Cream	Fairly soft.	P.C.E. = 16½. Probably requires non-plastic material. Open-burning clay—needs denser addition for vitrified ware.
					04	19.1	3.7	Light buff	Fairly hard.	
					02	14.8	5.4	Yellow	Hard.	
					6	10.7	7.5	Yellow	Very hard.	
110	Mile 18.5, west of Prince George	Light-grey non-calcareous clay	35.3 per cent water; works well and very plastic	Cracks at 85° C.; av. shrinkage, 9 per cent	08	21.3	0.8	Cream	Fairly hard.	P.C.E.=20+.
					04	17.4	2.8	Buff	Fairly hard.	
					6	10.6	5.7	Buff	Hard.	
111	Giscome Rapids	......	......	......	......	......	......	......	......	Excellent clay. *See* this report, page 30.
112	Mile 81.8 on C.N.R. east of Prince George, also Mile 83	Bluish plastic clay in cut; buff plastic clay	......	......	......	......	......	......	Burns light buff to salmon.	Suitable for pottery.
113	Mile 89.8 on C.N.R. east of Prince George	Bluish plastic clay	......	......	......	......	......	......	Burns salmon.	Suitable for brick and tile.
114	Mile 103.3 on C.N.R east of Prince George—south side of highway	Blue-grey clay	......	......	......	......	......	......	......	Suitable for brick.
115	Vanderhoof area — Nechako River bank	Grey slightly calcareous clay	24.5 per cent water; has fair plasticity and works well	Safe drying at 85° C.; av. shrinkage, 4.3 per cent	06	17.5	0.3	Light brown	Soft.	P.C.E.=4. Suitable for common brick.
					04	15.3	1.3	Light brown	Soft.	
					02	10.2	3.2	Brown-red	Hard.	
115	Fort St. James road, 3 miles from Vanderhoof	Light-brown calcareous clay	34.4 per cent water; has good workability and plasticity	Cracks slightly at 85° C.; av. shrinkage, 7.3 per cent	06	21.6	1.0	Dark salmon	Fairly soft.	P.C.E.=4. Suitable for common brick and tile, probably needs sand to counteract shrinkage.
					04	7.2	7.7	Dark red	Very hard, poor red.	
					02	1.9	9.5	Dark red	Vitrified.	

						Per Cent	Per Cent			
116	Fraser Lake — road-cuts south of settlement	Light-brown calcareous clay	29 per cent water; works well, fair plasticity	Safe drying at 85° C.; av. shrinkage, 6.6 per cent	04	19.0	......	Salmon	Soft, slight scum.	P.C.E.=2½. Very short *firing range, poor* colour, and some scumming and warping.
					01	0.2	11.7	*Dark brown*	*Very hard, warped.*	
117	Smithers — brickyard 1 mile north of town	Soft buff clay	29 per cent water; very *plastic and* works well	Cracks badly during *moderately rapid* drying; av. shrinkage, 8 per cent	08	17.2	1.1	Dark salmon	Fairly hard.	P.C.E.=1½. Poor colour and cracks badly. Was used for brick.
					06	14.4	2.3	Dark salmon	Hard.	
					03	2.0	8.4	Brown-red	Vitrified.	
118	Terrace—airport hill cut	Light-brown fine-grained *non-calcareous clay*	29.5 per cent water; *works well and is* very plastic	Cracks at 85° C.; av. *shrinkage,* 8.6 per cent	06	15.0	3.0	Dark salmon	Fairly hard, cracked.	P.C.E.=3. Short firing range and cracks. Other clay at Remo and Turner's ranch.
					04	10.6	5.3	Medium red	Very hard, slight cracking.	
					01	0.0	10.0	Dark red-brown	Vitrified.	
119	Prince Rupert	Very plastic gritty clay	22 per cent water required	Av. shrinkage, 5.1 per cent; tensile strength, 126 p.s.i.	010	14.3	0.0	......	......	Ref.: *G.S.C. Mem.* 47, 1914, p. 63. Good for drain-tile and pressed brick.
					05	9.6	1.2	Deep red	Steel hard.	
					1	8.6	2.7	Red	......	
					6	......	......	......	Fused.	
120	Porcher Island	*Glacial clay, large deposit*	......	......	......	......	......	......	......	Ref.: G.S.C. Mem. 47, 1914, p. 63. Also deposits on other islands.
121	Graham Island	Low-grade glacial clay in Hanna Valley, Yakoun Valley, and other places; grey and plastic	......	......	......	......	......	......	......	Ref.: G.S.C. Mem. 88, 1916, p. 172. Suitable *for common brick and* perhaps low-grade pottery.

TABLE IV.—BRITISH COLUMBIA SHALE DEPOSITS

Map No.	Location	Description	Workability	Drying Characteristics	Firing Characteristics: Cone	Absorption	Shrinkage	Colour	Miscellaneous	Remarks
						Per Cent	Per Cent			
1	Suquash	Dark-grey hard laminated tertiary shale	31 per cent water; is fairly plastic	Tendency to crack on drying	05	13.6	....	Red	Nearly steel hard.	Ref.: G.S.C. Mem. 25, 1913, p. 81.
					3	....	....	....	Fused.	
		Light-grey hard shale	40 per cent water; is plastic	Cracked on fast drying; av. shrinkage, 14 per cent; tensile strength, 95 p.s.i.	010	8.5	7.0	Light buff	....	Ref.: As above. Smoothest and most plastic shales on Vancouver Island.
					05	8.5	7.0	Light buff	Barely steel hard.	
					03	8.5	7.0	Light buff	....	
					2	....	....	....	Fused.	
8	Comox	3- to 5-foot lens of dark-grey shale associated with coal	15 per cent water; feebly plastic, moulded with difficulty	Av. shrinkage, 2.6 per cent	010	16.0	0.55	Dirty drab	Doesn't burn, steel hard at cone 5.	Ref.: G.S.C. Mem. 24E, 1912, p. 144. Used by B.C. Pottery Company Limited as stiffener with more plastic clay.
					03	13.47	1.4	Drab		
					1	13.72	2.3	Drab		
					5	6.31	5.0	Drab		
8	Courtenay—in city on bank of Puntledge River	Trent River formation of Nanaimo series	15.5 per cent water: fair plasticity and will flow through hollow-ware die	Av. shrinkage, 5 per cent	09	12.0	1.0	Buff	Hard, strong.	Ref.: G.S.C. Sum. Rept., 1922, Pt. A, p. 58A. Suitable for building bricks, hollow ware, and dry-press facebrick.
					06	12.0	1.0	Buff	Hard, strong.	
					03	3.0	6.5	Dark brown	Very hard, strong.	
				Dry press	06	13.0	....	Red buff	Hard, strong.	
					03	4.0	....	Brown	Very hard, strong.	
9	Union Bay—Lots 2 and 26	Partly weathered shale	21 per cent water; is slightly plastic	Av. shrinkage, 4.3 per cent; tensile strength, 65 p.s.i.	010	15.9	0.3	....	....	Ref.: G.S.C. Mem. 47, 1914, p. 61.
					05	10.0	4.4	Red-brown	....	
					03	4.7	4.6	....	....	
					1	2.9	6.3	....	Hard.	
					3	0.0	5.7	....	....	
					4	....	....	....	Fused.	
	Big Slide	7 feet of shale	32 per cent water; good workability	Safe drying; av. shrinkage, 6 per cent	010	24.3	2.0	Salmon	Fairly hard.	P.C.E.=9½. Suitable for common wares. Colour poor.
					06	22.6	2.8	Salmon	Hard.	
					03	17.1	5.4	Dark salmon	Very hard.	
9	Wellington Colliery	Cretaceous fireclay from coal mine	....	....	8	....	....	....	Fused	Ref.: B.C.M.M. 1908, p. 185. Brickyard made brick, blocks, and fire-brick about 1905.
11	Alberni — various places around town	Rock is black dense homogeneous fine-grained mud; rock in beds as much as 15 feet thick; non-calcareous	14.5 per cent water; low plasticity; can not be used alone and needs addition of plastic clay	Av. shrinkage, 4 per cent	09	15.0	0.0	Pink buff	Strong, hard, scummed.	Ref.: G.S.C. Sum. Rept., 1922, Pt. A, p. 57A.
					06	14.5	0.0	Pink buff	Strong, hard, scummed.	
					03	13.0	0.5	Pink buff	Strong, hard, scummed.	
				Dry press	06	14.0	....	Pink buff	Fairly hard, friable.	
					03	13.0	....	Pink buff	Hard, friable at edges.	
15	Nanaimo—East bank of Nanaimo River, 1 mile from mouth	20-foot bank of bluish-grey shale; Cedar shales	Very gritty and has poor plasticity	Av. shrinkage, 4 per cent	010	....	....	Red	Too gritty for brick.	Ref.: G.S.C. Mem. 25, 1913, p. 77.
					1	....	....	....	Fuses.	

						Per Cent	Per Cent			
	Railway above Extension	Haslam shales; dark, fine-grained, and gritty	Feebly plastic and wet, moulded with difficulty	Av. shrinkage, 6 per cent	010	13.8	1.0	Red	Good colour.	Ref.: As above.
					05	10.4	2.0	Dark red	Steel hard.	
					1	2.5	3.6	Dark red		
					3	3.0	4.6	Dark red		
					5	1.8	5.0	Dark red		
	Wellington shale		Feebly plastic and hard to wet mould	Av. shrinkage, 5 per cent	010	10.5	1.0			Ref.: As above. Dry-press bricklets at cone 05 gave good hard red body with 3 per cent fire shrinkage and 4.4 per cent absorption.
					05	9.5	1.8			
					03	8.7	3.8			
					1				Past vitrification.	
					2				Fused.	
	East Wellington—Mountain Brick and Tile Company	*Hard shale*		Av. shrinkage, 4.6 per cent; tensile strength, 70 p.s.i.	010	12.0	0.4		Fairly hard.	Ref.: G.S.C. Mem. 47, 1914, p. 60. Possibly used for common brick.
					05	8.7	1.4	Red	Steel hard.	
					03	5.5	3.0			
					1		2.4		Softening.	
	Extension mine	Shale								Ref.: B.C.M.M. 1908, p. 185. P.C.E.=8. SiO_2, 59.4; Al_2O_3, 19.7; Fe_2O_3, 8.7; CaO, 1.3; MgO, 0.7; Ig. loss, 10.4.
16	Gabriola Island — Evans, Coleman & Evans plant	Weathered part of lower shale of Northumberland formation about 15 feet thick	29.6 per cent water; works well and has good plasticity	Surface cracks in rapid drying; av. shrinkage, 7.5 per cent	06	15.1	2.1	Salmon	Fairly hard.	Ref.: G.S.C. Mem. 25, *1913, p. 77; Mem.* 47, 1914, p. 57; Mem. 65, 1915, p. 17. P.C.E.= 9½. Used to make brick.
					03	4.9	8.5	Brown-red	Very hard.	
					1	0.6	10.4	Dark red	Steel hard.	
		Under blue clay	18 per cent water; fair plasticity	Av. shrinkage, 5 per cent	010	12.54	0.6			
					05	12.07	4.0			
					1	2.45	6.0	Red		
					3	5.0	3.0			
22	Pender Island — Coast Shale Brick Company Limited		*Moderate plasticity if* ground fine	Av. shrinkage, 3.8 per cent; tensile strength, 90 p.s.i.	010	14.7	0.8	Red-brown		Ref.: G.S.C. Mem. 47, 1914, p. 59.
					05	11.5	1.7	Red-brown	Steel hard.	
					03	4.4	2.0	Red-brown		
					1	1.0	5.0	Dark brown		
					3				Fused.	
23	Hillbank, half a mile west of station on E. & N. Railway on bank of Koksilah River—Cow*ichan* Metallic Brick Company	Upper Cretaceous shale exposed for 600 feet along river		Av. shrinkage, 7 per cent; tensile strength, 105 p.s.i.						*Light red to dark brown* when burned. SiO_2, 57; Al_2O_3, 17.84; Fe_2O_3, 8.56; CaO, 2.00; MgO, 2.78; alkalis, 3.52; Ig. loss, *8.30.*
38	Burrard Inlet—south shore near Second Narrows	Top 6 to 10 feet of grey-white clay shale	Rather crumbly, short texture when wet	High shrinkage, cracks on drying	9				Fuses.	Ref.: G.S.C. Mem. 135, 1923, p. 75. Fire shrinkage is excessive.
		Blue-grey under shale	*Good plasticity* and works well mixed with water	*Cracks badly on drying*	9				No sign of fusion, dark buff, hard, and dense.	Semi-refractory but excessive shrinkage.

TABLE IV.—BRITISH COLUMBIA SHALE DEPOSITS—*Continued*

Map No.	Location	Description	Workability	Drying Characteristics	Firing Characteristics: Cone	Absorption	Shrinkage	Colour	Miscellaneous	Remarks
						Per Cent	Per Cent			
39	Barnet—Kask's Corner	Lowest 6 feet of greenish sandy shale	25.2 per cent water; rather short, sandy, but works fairly well	Cracked drying at 85° C.; av. shrinkage, 7.8 per cent.	04	12.6	1.5	Light red	Soft.	P.C.E.=13½. Good shale with long firing range and good colours. Should be suited for common brick, drain-tile, hollow tile, face-brick. May need sand added.
					01	7.3	4.3	Dark red	Hard.	
					2	6.3	4.7	Dark red	Hard, slight cracking.	
		Yellow-grey clay, non-calcareous; above last one	27 per cent water; slightly gritty but works well	Safe drying at 85° C.; av. shrinkage, 6.4 per cent	04	15.3	2.3	Dark red	Rather soft.	P.C.E.=13. Good clay with very long firing range and good colours.
					01	10.0	4.3	Good red	Fairly hard.	
					2	9.5	4.9	Good dark red	Hard.	
					6	3.7	6.3	Dark red-brown	Steel hard, some cracking and blistering.	
51	Whonnock—Blue Mountain									For details *see* this report, page 26.
56	Clayburn									For details *see* this report, page 19.
59, 60, 61	Kilgard									For details *see* this report, page 19.
74	Merritt—Inland Coal and Coke Company Limited	Grey shale from roof of No. 1 seam, 20 feet thick	22 per cent water fair plasticity but some coarse grit	Av. shrinkage, 5 per cent	010	12.3	2.4	Light pink		Ref.: G.S.C. Mem. 25, 1913, p. 71. Clay commends itself for long firing range.
					05	7.9	4.3	Light pink		
					03	6.4	5.7	Light pink		
					1	2.6	6.0	Light pink		
					3	2.6	6.0	Light pink		
					5	2.4	6.3	Grey		
					9				Vitrified.	
					15				Still vitrified.	
75	Tulameen	Thin bed massive clay with coal; underclay from Granite Creek area	Smooth and sticky but very refractory; burns white and almost infusible							Ref.: G.S.C. Mem. 26, 1913, p. 180. Suitable for pottery.
77	Princeton—Collins Gulch	From coal tunnel	Quite plastic	Checks rapidly on air drying; pre-heating to 550° C. permitted slow drying without cracking; av. shrinkage, 5.3 per cent	5	6.8	8.0			Ref.: G.S.C. Mem. 24E, 1912, p. 116. Not fire-clay but makes excellent pressed brick if cracking overcome.
					13				Not fused.	

						Per Cent	Per Cent			
	Coalmont	Floor of coal seam of Columbia Coal and Coke Company	29 per cent water; quite plastic but due to lime; will disintegrate if not burned hard enough; will flow through die	Av. shrinkage, 8.3 per cent; tensile strength, 150 p.s.i.	010	—	—	—	Crumbled in few days, colour poor.	Ref.: G.S.C. Mem. 47, 1914, p. 51.
					05	—	—	—		
79	Hope-Princeton Highway	Princeton shale near Whipsaw Creek	21 per cent water; short but works fairly well	Safe to rapid dry; av. shrinkage, 3.6 per cent	03	15.0	0.0	Light red	Soft.	P.C.E.=4. Firing range short. Possible use as common brick, tile, and facebrick.
					1	8.2	4.4	Light brown	Hard.	
86	St. Eugene Mission—close to south bank of St. Mary River	Non-calcareous buff kaolinized argillite	36 per cent water; works well and has fair plasticity	Safe to rapid dry; av. shrinkage, 5.6 per cent	04	25.4	1.0	Light salmon	Soft.	P.C.E.=17. Possible use as an open-firing stoneware clay, but maturing temperature higher than most stoneware clays.
					02	23.8	1.3	Light salmon	Soft.	
					6	14.2	4.7	Salmon	Fairly hard.	
					9	7.4	8.0	Light dirty salmon	Very hard.	
88	Cranbrook—Near Eager on Fort *Steele road*	Cambrian red shale	29 per cent water; fair plasticity and *works fairly well*	Safe to rapid dry; av. shrinkage, 4.4 per *cent*	03	16.8	2.0	Salmon	Fairly soft.	P.C.E.=15½. Should be suitable for facebrick.
					1	8.1	6.5	Medium red	Very hard.	
92	Lizard Creek	Upper beds—fine-grained shale; light brown in colour	33.5 per cent water; has good plasticity and works well	Small surface cracks on rapid drying; av. shrinkage, 7.1 per cent	06	11.5	5.7	Dark salmon	Hard.	P.C.E.=9. Suitable for common brick and tile. Some could be used for facebrick with sorting.
					03	0.5	10.7	Dark red	Steel hard, near vitrification.	
		Lower beds of dark-grey shale	27.5 per cent water; has good plasticity and works well	Slight tendency to crack on rapid drying; av. shrinkage, 5.7 per cent	06	14.2	2.7	Dark salmon	Fairly hard.	P.C.E.=4½. Short firing range but should be suitable for common brick and tile.
					03	13.3	2.0	Light red	Hard.	
					1	3.8	6.3	Red	Very hard.	
93	Fernie—first cut up branch line C.P.R. to Morrissey	Very gritty grey calcareous shale	Too low plasticity for wet moulding; dry-press bricklets only	—	05	22.9	0.0	Buff	—	A number of shale outcrops were examined along Coal Creek, but all were too gritty. Sample tested makes good-looking brick but not recommended.
					4	—	—	—	Fused.	
95	Crowsnest — half a mile *from Summit Station on* road	Sandy granular shale	19.7 per cent water; *poor plasticity; too* sandy for die; can be wet moulded	Av. shrinkage, 4 *per cent; tensile* strength, 45 p.s.i.	010	10.0	1.0	Red	Hard.	—
					05	6.7	1.3	Red	Steel hard.	
					03	5.4	2.0	Red	—	
					1	2.0	—	—	Slight swelling.	
				Dry press	010	9.51	1.0	—	Dry press best for working.	
					05	7.0	1.0	—		
100	Williams Lake	White zone in tuff or ash series; finely banded; white is mineralized; small quantity	Short but works fairly well	—	03	19.4	0.0	White	Fairly hard.	P.C.E.=19.
					3	19.0	0.0	White	Fairly hard.	
					10	19.0	0.0	White	Fairly hard.	
101	Australian Creek	Brown beds, 5 feet thick, above main lignite seam	Punky, crumbling body when wet	—	010	—	—	Pale red	Hard, porous.	Ref.: G.S.C. Mem. 118, 1920, p. 12. Clay bloats at higher temperature. Suitable for poor-grade common brick.
					02	—	—	Red-brown	Vitrified.	

TABLE IV.—BRITISH COLUMBIA SHALE DEPOSITS—*Continued*

Map No.	Location	Description	Workability	Drying Characteristics	Firing Characteristics: Cone	Firing Characteristics: Absorption	Firing Characteristics: Shrinkage	Firing Characteristics: Colour	Firing Characteristics: Miscellaneous	Remarks
						Per Cent	Per Cent			
102	Australian Cariboo Collieries	Non-calcareous dark-brown shale	57.4 per cent water; very plastic, slightly sticky, works fairly well	Cracks even on slow drying; av. shrinkage, 13.6 per cent	08	17.2	3.0	Dark salmon	Fairly hard.	P.C.E.=10.
					04	4.9	8.7	Light red	Very hard.	
					02	2.0	9.5	Light red	Steel hard.	
109	Nechako—Mile 13 on C.N.R. west of Prince George	Grey to black shales overlying black diatomite; 4 or 5 feet of white clay under the diatomite								
122	Graham Island—Slate Chuck Valley	Haida formation; black fine-grained massive hard shale, highly carbonaceous								Ref.: G.S.C. Mem. 88, 1916, p. 55. SiO_2, 44.78; Al_2O_3, 36.94; Fe_2O_3, 8.46; H_2O, 7.15; carbon, 3.18.
	British Pacific Coal Company Limited	Mixture upper and lower shales	Fairly plastic	Av. shrinkage, 4.5 per cent; tensile strength, 50 p.s.i.	010	14.0	1.0	Light buff		Ref.: G.S.C. Sum. Rept., 1912, p. 40. Could be used for common fire-brick.
					05	13.0				
					1		1.6			
					7				No fusion.	

INDEX

Not all localities of clay and shale deposits, indicated on Figure 1, and numbered references to them in Tables III and IV, are indexed.

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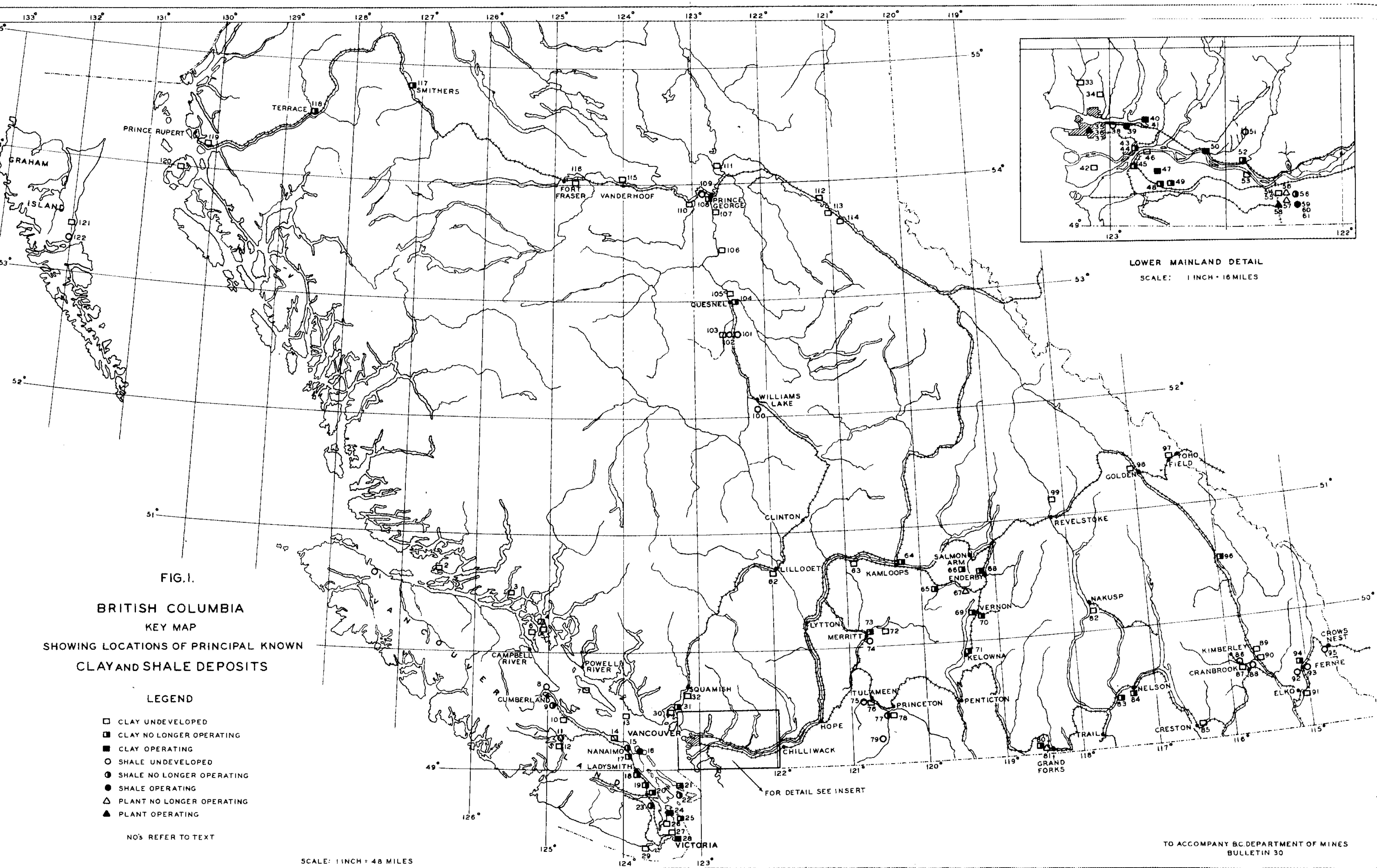


FIG. I.

BRITISH COLUMBIA

KEY MAP

SHOWING LOCATIONS OF PRINCIPAL KNOWN

CLAY AND SHALE DEPOSITS

LEGEND

- □ CLAY UNDEVELOPED
- ◨ CLAY NO LONGER OPERATING
- ■ CLAY OPERATING
- ○ SHALE UNDEVELOPED
- ◑ SHALE NO LONGER OPERATING
- ● SHALE OPERATING
- △ PLANT NO LONGER OPERATING
- ▲ PLANT OPERATING

NO'S REFER TO TEXT

SCALE: 1 INCH = 48 MILES

TO ACCOMPANY B.C. DEPARTMENT OF MINES
BULLETIN 30

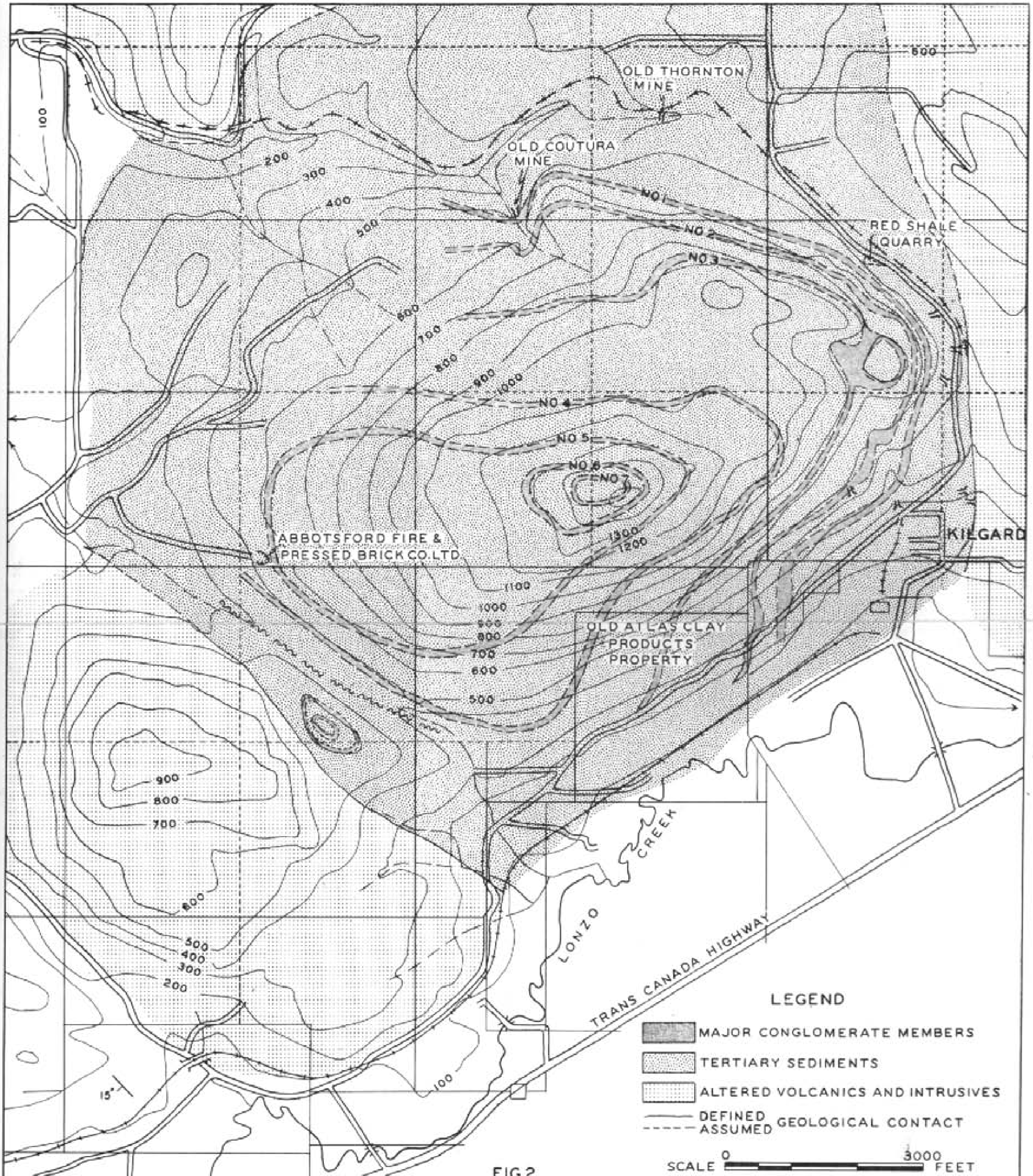


FIG.2
SUMAS MOUNTAIN AREA
GEOLOGY

TO ACCOMPANY B.C.DEPARTMENT OF MINES
BULLETIN 30

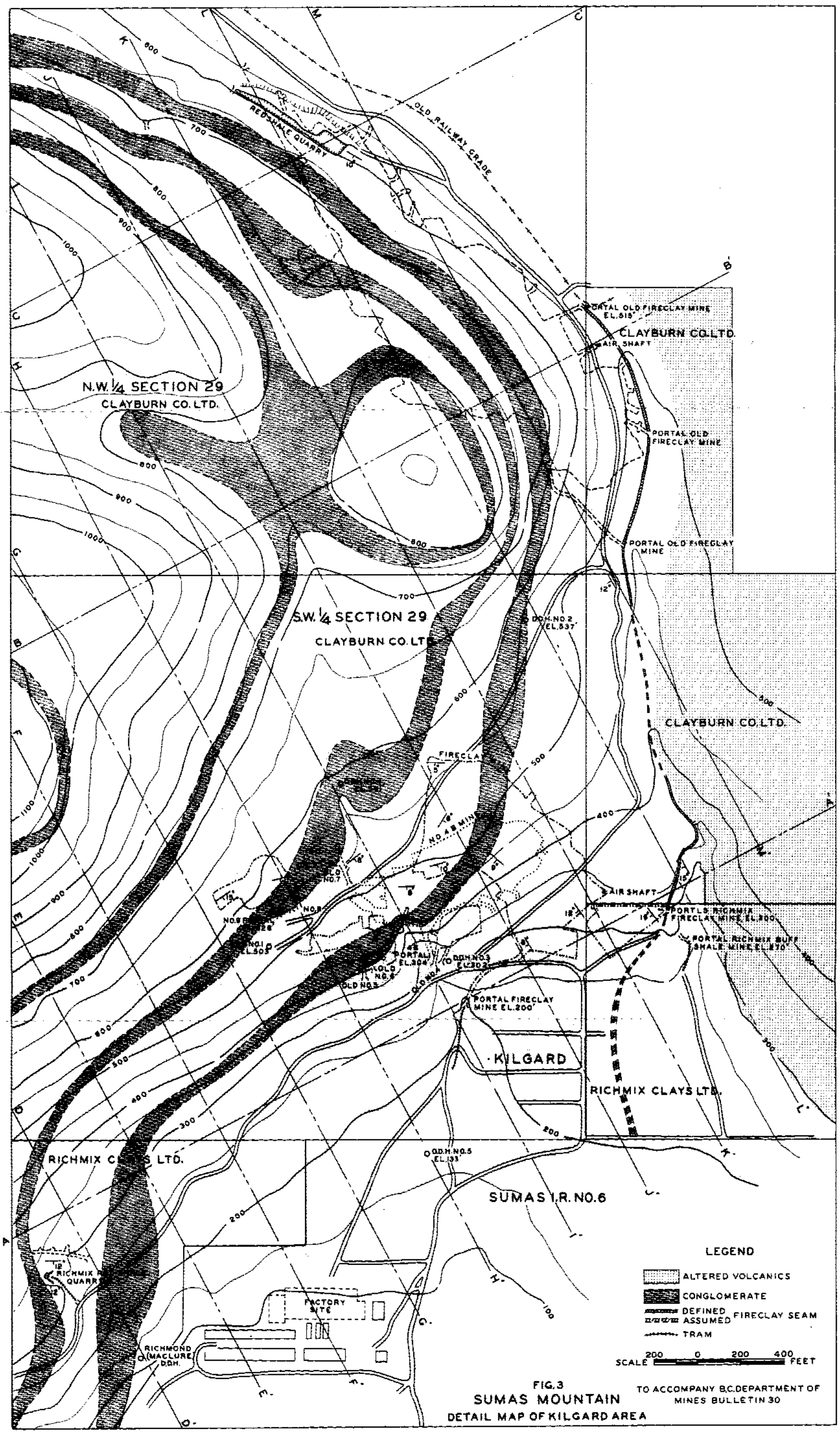


FIG. 3
SUMAS MOUNTAIN
DETAIL MAP OF KILGARD AREA

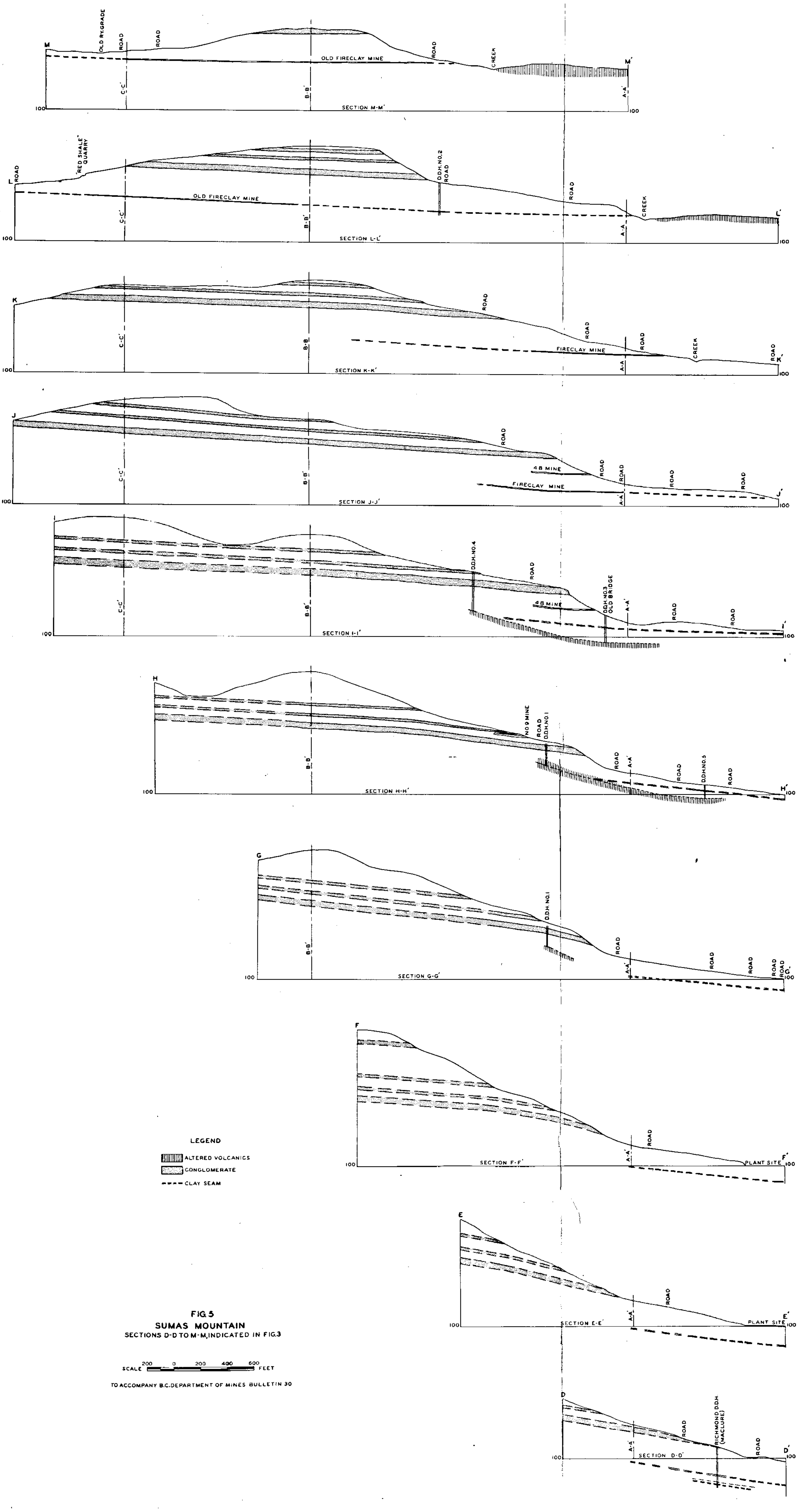
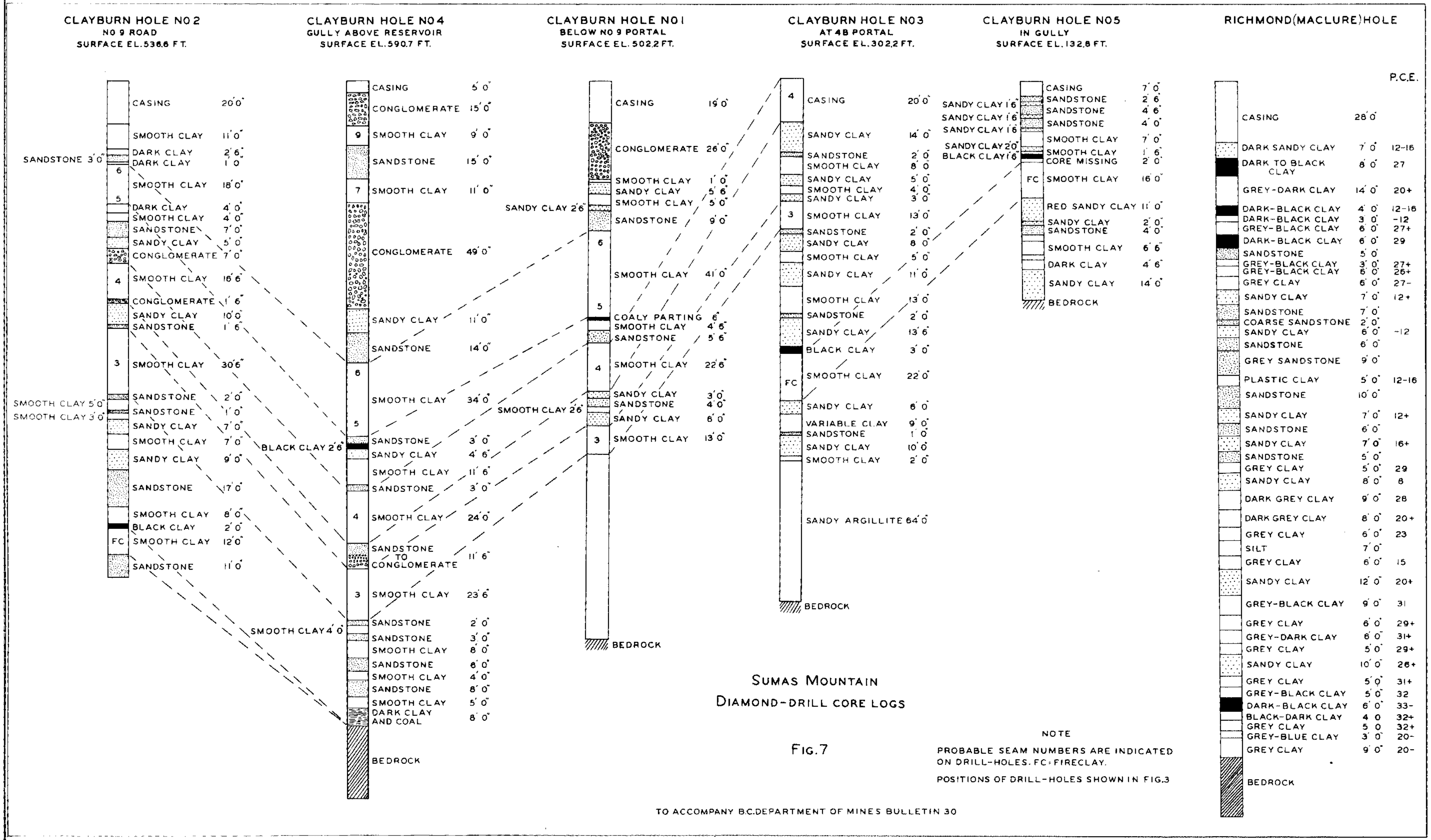


FIG. 5
SUMAS MOUNTAIN
SECTIONS D-D TO M-M, INDICATED IN FIG. 3

TO ACCOMPANY B.C. DEPARTMENT OF MINES BULLETIN 30

#30 ①



SUMAS MOUNTAIN
DIAMOND-DRILL CORE LOGS

FIG. 7

NOTE

PROBABLE SEAM NUMBERS ARE INDICATED ON DRILL-HOLES. FC: FIRECLAY.

POSITIONS OF DRILL-HOLES SHOWN IN FIG. 3

TO ACCOMPANY B.C. DEPARTMENT OF MINES BULLETIN 30