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DEPARTMENT OF MINES AND TECHNICAL SURVEYS

PAPER 63-35

THE GEOLOGY AND CERAMIC PROPERTIES OF SHALE FROM BACON POINT, PRINCE EDWARD ISLAND

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V. K. Prest and J. G. Brady

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Figure 1. Schematic diagram of geology, Bacon Point coastal area, Hillsborough Bay, Prince Edward Island .... in pocket

THE GEOLOGY AND CERAMIC PROPERTIES OF SHALE FROM BACON POINT, PRINCE EDWARD ISLAND

By

V.K. Prest and J.G. Brady[1]

INTRODUCTION

A geological survey of both the bedrock and surficial deposits of Prince Edward Island was undertaken by the Geological Survey of Canada in 1953 and work has continued to the present. It has long been known that the surface bedrock formations on the Island do not contain economic mineral deposits such as are known in the adjacent Maritime Provinces, for they are younger than both the host and source rocks of such deposits in New Brunswick and Nova Scotia. It was realized early in the current survey that any possible economic mineral development on the Island would have to be in the non-metallic or industrial mineral field. One possible development might be the establishment of a brick and tile industry. Sufficient bricks to satisfy every local demand were produced at several sites on the Island in the early part of this century. Though some good bricks were made, the product was not uniformly controlled nor was the demand sufficient to maintain the industry, and production has long since ceased. Furthermore, the 'brick clay' used in most cases was probably a clay till or other surface material, and contained some undesirable foreign objects. Such a raw material could not prove satisfactory today. There is no sizeable deposit of clay on the Island having suitable properties for the manufacture of brick. The bedrock formations, however, include considerable 'shale'[2] or mudstone, some of which has characteristics that permit the production of brick and tile. Areas of 'shale' were, therefore, studied by the writers with an 'eye' toward continuity of beds, ease of access, and proximity to possible Island demand. One promising site was located along the Bacon Point shore, on the northwestern side of Hillsborough Bay.

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[1] Ceramic Section, Mineral Processing Division, Mines Branch, Department of Mines and Technical Surveys, Ottawa.

[2] The term 'shale' as used in this report refers to fine-grained 'mud' rocks whether or not a fissile parting is present and is so used in the ceramic industry. The term mudstone is more appropriate as it does not imply a fissile parting, yet includes rocks composed of particles in both the fine-silt size and clay-size ranges, and admixtures of these particle-sizes.

Preliminary tests made by the Ceramic Laboratory, Mines Branch, Ottawa, on grab samples from Bacon Point, indicated that the 'shales' were in part at least satisfactory for making common brick and drain tile. Further tests were subsequently performed on larger samples channelled from the cliff face near Bacon Point, and again indicated that the 'shale' was satisfactory for brick making. The results of these tests, as well as a résumé of earlier work on Prince Edward Island clays and 'shales' is contained in a report by Brady (1958)[1].

In order to establish continuity of favourable beds a drilling program was initiated and core samples recovered from eleven holes located over a distance of about 2 miles (Fig. 1). These cores were carefully logged, the indicated geology checked against the coastline exposures, and a schematic diagram of the geological units of the Bacon Point area was then compiled (Fig. 2). Representative samples of the shale (mudstone) from the drill cores were also tested in the Ceramic Laboratory of the Mines Branch. The results of these tests are included in the present report in order that persons or agencies interested in the development of the 'shales' (mudstones) of Prince Edward Island for ceramic purposes may have a better picture from which to evaluate such a venture and to plan a detailed drilling or test-pitting program in any favoured site.

Acknowledgments

The writers are indebted to the residents of the Cumberland (Bacon Point) area for their cooperation and good-will in connection with the drilling program carried out in 1961. They also acknowledge the assistance given by G.H. Crowl in the course of sampling the cliff face at Bacon Point. Personnel of the Department of Industry and Resources, and in particular B. Graham Rogers, provided useful services without which the drilling project could not have been completed.

Previous Work

Though the presence of some Coal Measures (Carboniferous age) plants in the rocks of the south and west shores of Prince Edward Island was first mentioned by Dawson (1842) the first significant account of the geology was that of Gesner (1846). This report contains an account of his geological studies in 1844 and 1845 with the aid of grants approved by the Queen and the local legislature respectively.

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[1] Dates or names and dates in parentheses refer to publications listed in the References.

Later, the rocks were studied in more detail by Dawson under the authority of the local government, at which time they were believed to include Carboniferous (Coal Measures) and considerably younger Triassic rocks (Dawson and Harrington, 1871). Thereafter several officers of the Geological Survey of Canada, notably Ells (1885), made important contributions regarding the age, structure, and character of the Island rocks. An Island naturalist, Francis Bain, studied the flora of the south and west shore rocks and published numerous articles thereon during the 1880's and 1890's. More recently Milligan (1949) carried out a regional study of the rocks and mineral resources for the provincial government.

The Triassic age assigned to some of the rocks on the Island was based on misidentification in 1854 of part of a jaw bone of an ancient animal, found near New London some time earlier. For many years this jaw bone was regarded as belonging to a reptile, but in 1905 it was properly identified as a pelycosaur and the younger Island rocks were thereupon relegated to the Permian system. A palaeobotanist also placed the south shore rocks in the Permian (Holden, 1913). Recent studies of bone fragments from many parts of the Island indicate that most of the 'red beds' are Permian (Langston, 1963). The rocks on Governor Island in Hillsborough Bay, and those of part of western Prince Edward Island alone remain as representative of the Upper Carboniferous (Coal Measures) formations at the present time (Barss, Hacquebard, and Howie, 1963). For a comprehensive list of references pertinent to the geology of Prince Edward Island the reader is referred to the publication by Langston (1963).

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GENERAL GEOLOGY

The bedrock of Prince Edward Island is sedimentary in origin and predominantly red. Sandstone is by far the most prevalent rock type; conglomerate or pebbly layers and 'shale' (mudstone) layers are important units in some parts of the Island. Intraformational conglomerate and breccia (claystone fragments in a sandstone matrix and bonded together with $CaCO_3$) are widespread though minor constituents of the predominantly sandstone assemblage. Most of the rocks are Permian in age, and hence about 250 million years old; somewhat older Pennsylvanian beds (300 million years) occur on Governor Island in Hillsborough Bay, and also possibly along the west coast of O'Leary and Tignish map-areas. All the rocks are continental in origin, that is, they were deposited on land as alluvial fan, flood plain, and stream deposits, and to a minor extent in shallow water lakes or estuaries. As a consequence the rock units are markedly lenticular, and mappable units are difficult to establish and trace over any significant distance.

The bedrock of Bacon Point coastal area consists of intercalated and lenticular beds of sandstone, siltstone, and claystone (the finer grained rocks may be collectively termed mudstone, as mentioned in the footnote on page 1), with minor lenses of intraformational claystone breccia. The sandstone is fine to medium grained and much more abundant than the mudstone. It is generally non-calcareous, owing in part at least to the removal of carbonate by downward percolating groundwater. Where carbonate is present in the sandstone the red colour is less intense and a few thin beds are even distinctly grey. The mudstones are distinctly red (except for greenish grey streaks where leached by groundwater along bedding planes); and they generally react to dilute HCl, indicating a calcareous content[1].

The geological formations on the Bacon Point shore are on the northwestern side of a fold or elongate dome, the axis of which lies under Hillsborough Bay and trends northeasterly. The mudstone horizon of the Bacon Point area has been traced eastward through Lobster Point, Alexandra, and Cherry Valley, and thence south and southwest through Vernon and Orwell Cove onto Prim Point Peninsula, 10 miles across Hillsborough Bay from Bacon Point and on the other side of the fold structure. The location of workable mudstone layers over the length of this belt, however, has not been determined. Ceramic tests were performed on a mudstone sample from Prim Point Peninsula; the 'fired' characteristics were considered satisfactory (Brady, 1958), but the lenticularity and thinness of these beds does not appear to warrant further attention. Westward from Bacon Point the mudstone horizon has been traced reliably only as far as Nine Mile Creek. Beyond this locale mudstone occurs on both the south coast and inland in the western part of Eliot (West) River but the bedrock structure has not been worked out, nor have the ceramic properties been tested.

'Shales' (mudstones) are prevalent on the west coast of Prince Edward Island (Prest, 1962). Some of these were sampled for ceramic test purposes and satisfactory firing properties were indicated. The sample sites, however, are not in readily workable locales nor are they close to areas where brick is in demand. Thus, the Bacon Point area remains as the only locality outlined to date where mudstone satisfactory for brick-making purposes occurs in beds of adequate thickness and shows reasonable continuity both along the strike or trend of the beds as well as down dip, and where a possible market area is close by. Exploration along the strike or trend of the mudstone layers however should not be neglected.

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[1] The more calcareous the mudstone, the less likely it is to be a useful raw material for ceramic purposes.

BACON POINT DRILLING PROJECT

The locations of the vertical holes drilled by the Federal Department of Public Works are indicated on Figure 1 . The holes were collared alongside the fencelines leading from the Fairview-Cumberland-Rocky Point road south to the shore. Table I lists the pertinent information pertaining to the drill-hole locations and the samples taken for ceramic tests. The lot (and usually fence) lines are referred to as the number (with approximate distance) either east or west of the east side of the Cumberland Roman Catholic church.

Summary Logs of Drill Cores

The cores from the eleven (vertical) drill-holes were studied in some detail and the following geological logs provide a general summary of the character and thickness of the rock units present. Throughout these logs the term 'shale' is used for the claystones, whether or not a fissile parting is evident; it also includes most of the very fine grained siltstones. This usage is in keeping with that employed in the ceramic industry. The term mudstone may be used in place of 'shale'. The sandstone, siltstone and shale is dull red unless otherwise specified. The dry sandstone has Munsell colour equivalents around 10R5/2-4. The sandstone becomes greyish with increasing carbonate content; the greyer beds range around 7.5YR7-8/0-2; in places there is a slight greenish cast, close to 2.5YR6/1. The dry shale has Munsell colours that range from 10R5/3 through 10R4/4 to 10R3/6, and when wet may be as dark as 10R3/4.

Section Drilled (feet)	Lithology
	Hole No. 1
0-12.8	No core. Drillers log shows 1.5 ft. medium-firm sandy clay, 9.5 ft. stiff red clay, 1.8 ft. mixed clay and sandstone.
12.8-38	Sandstone; mostly fine grained massive, and medium grained micaceous, with some clay and clay-streaked partings and layers up to 6 inches thick.
38-39.5	Intraformational or shale breccia; red shale fragments in a grey sand matrix with a calcareous (carbonate) cement.

Table I. Bore-hole Localities and Samples Tested

Hole No.	Lot Line and Distance (feet) from Church	Distance from Road (feet)	Elev. of Collar (feet)	Total Depth (feet)	Sampled Section (feet)	Ceramics Lab. Sample No.
1	7W (3300')	350	102.6	51.5	Nil	Nil
2	" "	1,100	70.7	101.0	12.5-33.6	1131
					35.0-79.6	1132
					89.5-101.0	1133
3	2W (700')	900	73.5	104.0	25.0-33.5	1134
					46.0-53.0	1135
					53.0-63.5	1136
					63.5-90.3	1137
4	0 (0')	800	88.7	106.0	57.0-106.0	1138
5	1E (350')	500	75.3	205.8	60.0-75.5	1139
					80.0-104.0	1140
6	2E (800')	600	37.4	103.6	8.0-40.0	1141
					70.0-90.0	1142
7	6E (2350')	500	66.1	50.3	5.0-22.0	1143
8	9E (4650')	500	94.3	103.2	46-71	1144
					71-83	1145
9	16E (6600')	2,000	67.4	50.4	Nil	Nil
10	" "	1,500	134.0	154.0	35-55	1146
11	" "	775	134.3	99.0	43-49	1147

Section Drilled (feet)	Lithology
39.5-50	Sandstone; fine to medium grained, variably calcareous and locally manganiferous.
50-51.5	Shale.
	Hole No. 2
0-7.0	No core. Drillers log shows 2 ft. loose, sandy clay; 5 ft. friable sandstone.
7-12.5	Sandstone; fine grained.
12.5-49.5	Siltstone and shale; mostly fine-grained siltstone with shale layers; slightly to moderately calcareous. (Includes samples CL1131 and 1132.)
49.5-58	Sandstone; fine to medium grained, laminated to massive.
58-60.5	Shale.
60.5-78	Sandstone; fine to medium grained, streaky banded, scattered shale fragments.
78-78.5	Shale breccia.
78.5-89.5	Sandstone; massive to well laminated, calcareous.
89.5-101	Shale; slightly silty, strongly calcareous. (Sample CL1133.)
	Hole No. 3
0-10	No core. Drillers log shows 2.3 ft. loose sandstone, 4.7 ft. firm sandstone, 3.0 ft. friable sandstone.
10-23.5	Sandstone; fine to medium grained, laminated to massive, calcareous, locally manganiferous.
23.5-33.5	Shale; weakly to non-calcareous. (Includes Sample CL1134.)

Section Drilled (feet)	Lithology
33.5-46	Mixed siltstone, sandstone, and breccia; all calcareous.
46-90.3	Mixed shale and fine-grained siltstone; variably calcareous; bedding at 10° to core. (Includes samples CL1135, 1136, 1137.)
90.3-104	Sandstone; very fine to medium grained, calcareous.
	Hole No. 4
0-8	No core. Drillers log shows 1.5 ft. loose sand and clay, 6.5 ft. mixed sandy clay and sandstone.
8-38	Sandstone; fine grained, black-spotted, manganiferous; few inches of shale and breccia in lower part.
38-44.4	Mixed shale and siltstone; variably calcareous.
44.4-46	Shale breccia; streaky grey and red; calcareous.
46-106	Mixed shale and siltstone; streaky grey and red; variably calcareous. (Includes sample CL1138.)
	Hole No. 5
0-9	No core. Drillers log shows 2.3 ft. loose sand and clay, 6.7 ft. hard packed sandy clay.
9-49	Mixed siltstone and shale; variably calcareous, grading in places to fine-grained sandstone.
49-51.5	Sandstone; greyish, small shale spots, calcareous.
51.5-76	Shale and minor siltstone; mostly non-calcareous. (Includes sample CL1139.)
76-77	Sandstone; grey, crossbedded, calcareous.
77-112	Mixed shale and siltstone; variably calcareous. (Includes sample CL1140.)

Section Drilled (feet)	Lithology
112-126	<u>Sandstone</u>; fine to medium grained, calcareous.
126-155	<u>Shale and fine-grained sandstone</u>; variably calcareous
155-167.5	<u>Sandstone and siltstone</u>.
167.5-176.5	<u>Shale breccia</u>; streaky grey to red spotted; calcareous.
176.5-191.5	<u>Sandstone</u>; fine grained, massive; bedding at 25° to core; strongly calcareous.
191.5-196	<u>Shale and siltstone</u>.
196-201	<u>Siltstone and breccia</u>; greyish to blotchy red.
201-205.8	<u>Sandstone</u>; fine grained.
	<u>Hole No. 6</u>
0-8	No core. Drillers log shows 6 ft. loose to medium settled sand and clay, 2 ft. stiff clay.
8-61.5	<u>Shale</u>; becoming silty toward the bottom; variably calcareous. (Includes sample CL1141.)
61.5-70	<u>Sandstone</u>; purple-hued, fine to medium grained; spotted, calcareous.
70-90.5	<u>Shale</u>; slightly calcareous. (Sample CL1142.)
90.5-98.5	<u>Sandstone</u>; purple-hued (10R4/1), blotchy-brecciated toward bottom.
98.5-103.6	<u>Shale</u>; non-calcareous.
	<u>Hole No. 7</u>
0-5	No core. Drillers log shows 5 ft. loose to medium settled loam.

Section Drilled (feet)	Lithology
5-22	Shale; non-calcareous at top, becoming calcareous toward the bottom. (Sample CL1143.)
22-24	Sandstone; green-grey; fine to medium grained.
24-39	Siltstone and shale; variably calcareous.
39-45.5	Sandstone; slightly purplish (10R4/1), fine grained, massive, becoming bedded toward bottom; bedding at 10° to core.
45.5-50.3	Shale breccia and sandstone; calcareous.

Hole No. 8

0-7.7	No core. Drillers log shows 4 ft. loose to medium, settled loam, 3.7 ft. stiff clay.
7.7-22	Sandstone; greyish red; fine grained.
22-27	Shaly material; "ground core".
27-39.6	Sandstone; fine grained.
39.6-46.5	Sandstone and shale breccia.
46.5-83.5	Shale and silty shale; variably calcareous. (Includes samples CL1144 and 1145.)
83.5-103.2	Sandstone; fine grained, dull red to greyish; some shale granule layers mostly less than an inch thick; calcareous.

Hole No. 9

0-9.2	No core. Drillers log shows 2 ft. loam; 7.2 ft. stiff clay.
9.2-47	Sandstone; locally greyish; much lost core probably at shale breccia horizons.
47-50.4	Shale and silty shale; non-calcareous.

Section Drilled (feet)	Lithology
	Hole No. 10
0-5.5	No core. Drillers log shows 4.5 ft. loam, 1.0 ft. friable sandstone.
5.5-29	Sandstone; fine to medium grained.
29-55	Shale; variably calcareous. (Includes sample CL1146.)
55-105	Sandstone; fine to coarse grained; variably calcareous; mostly blotchy-flecked appearance, locally dense and massive.
105-134	Shale; slightly calcareous.
134-154	No core recovered.
	Hole No. 11
0-4.8	No core. Drillers log shows 4.8 ft. loam.
4.8-14.5	Sandstone; fine grained, massive.
14.5-19.5	Shale breccia; abundant small shale fragments.
19.5-21.4	Sandstone; fine grained, banded.
21.4-28	Siltstone and shale; variably calcareous.
28-43	Sandstone; fine to medium grained, massive; one thin shale bed.
43-51	Shale; chocolate red (10R3/6); slightly calcareous to non-calcareous. (Includes sample CL1147.)
51-56	Sandstone and shale breccia.
56-58	Shale; chocolate red (10R3/6).
58-89	Sandstone; thin shale fragment layers.

Section Drilled (feet)	Lithology
89-95.5	Shale; chocolate red (10R3/6); slightly calcareous.
95.5-99	Sandstone; green-grey to light red; calcareous.

Distribution of Shale Units

The relationships of the shale units along the coast and those encountered in the drill-holes are shown on Figure 1, a schematic diagram of the Bacon Point coastal area. This diagram gives an oblique "birds-eye" view of the land surface and the coastal cliffs as well as cut-away sections along those fencelines where drill-holes are located; the land surface has been pulled apart in these places, along the trend of the Fairview-Cumberland road, sufficiently to expose the full section above sea-level at the road. Horizontal distances are true distances within each block so that surface areas of shale may be determined, and for given thicknesses the tonnage of usable shale may be estimated.

The lenticular character of the beds is indicated. Sandstone beds thicken or thin unexpectedly so that a good working thickness of shale in one place may be rendered unworkable by a sandstone lens within a relatively short distance. It should also be borne in mind that similar relatively sudden changes in grain-size, mineralogy, carbonate content, and other physical properties within a mudstone layer may seriously affect its ceramic qualities. Great care will, therefore, have to be exercised in further sampling of any site selected for brick-making purposes.

Laboratory Procedures

The dried samples were crushed to pass through a 16-mesh Tyler laboratory screen. The crushed shale was mixed with water to a stiff plastic condition and the amount of water required (water of plasticity) was noted. Test specimens in the form of pyrometric cones and 4 x 1 1/2 x 1 1/4-inch briquettes were hand-moulded from the prepared materials. The plasticity and workability of the samples were noted. One briquette from each sample was submitted to rapid drying conditions at 185°F immediately after leaving the mould, and the results observed. The balance of the briquettes were dried slowly at room temperature and finally at 185°F in a laboratory dryer. The drying shrinkage was measured and calculated. The pyrometric cone equivalent (P.C.E.) or heat softening point was obtained in each case. The dried briquettes were then fired in an electrically heated laboratory furnace at cone 06 (approx. 1816°F), cone 04 (approx. 1922°F), cone 02 (approx. 2014°F), and cone 1 (approx. 2077°F). The fired colour, hardness, shrinkage, and water absorption after a 24-hour soak in cold water were determined.

One large sample (No. 1141), which is typical of most of the low plasticity shale samples, was extruded in a laboratory de-airing extrusion machine. The test bars were evaluated in the same manner as the hand-moulded specimens. The absorption ratio, 24-hr. cold/5 hr. boil (C/B ratio), was determined on the extruded samples.

The physical properties of the shales as determined from the above-mentioned test procedures are given in Table II.

Discussion of Ceramic Properties

The samples are common red-burning shales, which have P.C.E.'s of about 6 to 7. All samples are somewhat calcareous except numbers 1143 and 1147. Sample 1143 has the highest P.C.E. at cone 9. The samples dry safely and all of them except 1133 should extrude satisfactorily. Sample 1141, which is one of the more silty, non-plastic samples, extruded very well through a laboratory de-airing extrusion machine. The extruded bars are smooth, dense, and strong.

Samples 1132, 1134, 1142, 1143, 1146, and 1147 are the most plastic of the seventeen samples examined. They dry safely with drying shrinkage of about 4.5 to 6.0 per cent. The fired samples are fairly hard to hard, and are medium red colour at about cone 04. At cone 02 these plastic samples fire to a hard, dense red body having absorptions of about 8 per cent or less and fired shrinkages of about 2.5 to 5 per cent. The firing range is satisfactory up to this temperature. Beyond about cone 02 there is a fairly sudden change in absorption and shrinkage. Sample 1147 is hard at cone 06 and vitrifies at cone 1.

Samples 1131, 1135, 1136, 1137, 1138, 1139, 1140, 1141, 1144, and 1145 have fairly good to good workability, and fair to low plasticity. They dry safely and have drying shrinkages of about 4 to 5 per cent. The results of the extrusion tests on sample 1141 indicate that these samples will extrude readily. A slightly higher-firing temperature than for the plastic shales is required for producing a fairly hard to hard fired specimen from the less plastic samples. For a given firing temperature, their absorptions tend to be higher and their shrinkages tend to be lower than those of the plastic samples. The fired briquettes, in general, are fairly hard and are medium red to red at about cone 04 to 02. The firing range up to cone 02 is fairly long. Above cone 02 the shrinkage increases and the absorption decreases at a faster rate than at lower temperatures. A firing temperature of slightly above cone 02 is necessary to produce a hard, dense, red-coloured product such as face brick from the less plastic samples.

Sample 1133 is the least plastic of all the samples and may not extrude satisfactorily. It does not have desirable fired properties. It is noteworthy that this same shale horizon farther east has satisfactory ceramic properties, i.e. samples 1135 to 1145; and that sample 1141, though having low plasticity, did extrude readily.

The samples examined, with the exception of 1133, were found to be suitable for de-aired, extruded clay products such as face brick, common brick, and drain tile. Samples 1132, 1134, 1142, 1143, 1146, and 1147 were the most plastic. Samples 1131, 1135, 1136, 1137, 1138, 1139, 1140, 1141, 1144, and 1145 had fair to low plasticity but would extrude. Mixtures of the samples having the greatest plasticity with those having the least plasticity (with the exception of 1133) would also provide suitable raw materials for extruded clay products.

Laboratory tests indicate that some of the more plastic shales may be suitable for pottery manufacture, provided they are ground fine enough to produce high plasticity. Normally, however, shale is not a desirable raw material for pottery manufacture.

Table II

Average Ceramic Properties of Bacon Point Shale

Clay No.	Unfired Characteristics (of samples ground to - 16 mesh)	P.C.E.	Fired Characteristics					Remarks
			Cone No.	Fired Shrinkage (%)	Absorption (%)	Colour	Hardness	
1131 Hole 2	Red, calcareous shale, somewhat silty; rather good workability, fair plasticity, water of plasticity 22.3%, safe drying, drying shrinkage 5.1%.	Cone 6+ approx. 2200°F	06	0.0	14.3	Pale Red	Rather soft	Common red-burning shale, fairly good to good workability, fair to low plasticity. This sample will extrude and is suitable for extruded clay products.
			04	0.3	13.3	Medium red	Fairly soft	
			02	1.3	11.2	Fair red	Medium hard	
			1	4.8	4.1	Dark red	Very hard	
1132 Hole 2	Red, calcareous shale; good workability and plasticity, water of plasticity 24.4%, safe drying, drying shrinkage 5.9%.	Cone 6+ approx. 2200°F	06	0.9	13.8	Pale red	Fairly soft	Common, red-burning shale with good workability and plasticity. Suitable for manufacture of extruded clay products and for mixing with less plastic shales.
			04	2.5	10.5	Medium red	Fairly hard	
			02	4.8	6.2	Red	Very hard	
			1	8.2	0.3	Very dark red	Vitrified	
1133 Hole 2	Red, calcareous shale, somewhat silty; fair workability, short water of plasticity 19.6%, safe drying, drying shrinkage 4.3%.	Cone 6+ approx. 2200°F	06	+0.3*	15.6	Pale red	Soft	Common, non-plastic shale. Might require a plastic addition for extrusion.
			04	+0.3*	14.7	Light red	Fairly soft	
			02	0.0	14.1	Brownish medium red	Fairly soft	
			1	2.3	8.3	Brownish red	Hard	
1134 Hole 3	Red, very slightly calcareous shale; good workability and plasticity, water of plasticity 22.3%, safe drying, drying shrinkage 5.4%	Cone 6+ approx. 2200°F	06	1.2	12.6	Light red	Fairly hard	Same comments as 1132.
			04	3.0	9.0	Medium red	Hard	
			02	5.3	4.6	Red	Very hard	
			1	7.9	0.2	Very dark red	Vitrified	
1135 Hole 3	Red, calcareous shale, somewhat silty; fair workability, low plasticity, water of plasticity 20.9%, safe drying, drying shrinkage 4.7%.	Cone 7 approx. 2219°F	06	+0.2*	14.0	Light red	Fairly soft	Same comments as 1131.
			04	0.3	12.4	Medium red	Fairly hard	
			02	1.5	10.7	Fair red	Hard	
			1	4.3	4.9	Dark red	Very hard	

1136 Hole 3	Red, calcareous shale, somewhat silty; workability rather good, fairly plastic, water of plasticity 21.2%, safe drying, drying shrinkage 5.4%	Cone 6+ approx. 2200°F	06 04 02 1	0.5 1.5 2.7 5.0	12.8 11.1 9.0 3.1	Dark salmon Medium red Medium red Red	Fairly hard Medium hard Hard Steel hard	Same comments as 1131. This sample has a tendency to scum.
1137 Hole 3	Red, calcareous to very calcareous shale, somewhat silty; good workability, fair plasticity, water of plasticity 19.7%, safe drying, drying shrinkage 4.5%.	Cone 6+ approx. 2200°F	06 04 02 1	0.0 0.0 0.5 3.3	14.2 13.1 11.9 5.6	Pale red Light red Fair red Dark red	Fairly soft Fairly soft Fairly hard Very hard	Same comments as 1131.
1138 Hole 4	Red, calcareous shale, somewhat silty; rather good workability, fairly plastic, water of plasticity 22.3%, safe drying, drying shrinkage 4.7%.	Cone 6+ approx. 2200°F	06 04 02 1	0.0 0.3 1.0 3.2	14.2 12.9 11.5 7.1	Light red Medium red Fair red Dark red	Fairly soft Fairly hard Fairly hard Hard	Same comments as 1131.
1139 Hole 5	Red, calcareous shale, silty; fair workability, low plasticity, water of plasticity 20.9%, safe drying, drying shrinkage 4.6%.	Cone 7 approx. 2219°F	06 04 02 1	0.0 0.3 1.0 3.9	13.8 12.6 11.0 5.2	Pale red Medium red Fair red Dark red	Fairly soft Fairly hard Fairly hard Very hard	Same comments as 1131.
1140 Hole 5	Red, calcareous shale, silty; fair workability, low plasticity, water of plasticity 20.0%, safe drying, drying shrinkage 4.2%.	Cone 6+ approx. 2200°F	06 04 02 1	+0.2* 0.2 0.5 3.4	15.1 13.9 12.7 6.1	Pale red Medium red Fair red Dark red	Fairly soft Fairly soft Fairly hard Very hard	Same comments as 1131.
1141 Hole 6	Red, calcareous shale, silty; fair workability, low plasticity, water of plasticity 20.2%, safe drying, drying shrinkage 4.8%.	Cone 7 approx. 2212°F	06 04 02 1	+0.5* 0.0 0.7 2.9	14.5 13.2 12.0 6.4	Pale red Medium red Fair red Dark red	Fairly soft Fairly soft Fairly hard Very hard	Same comments as 1131. This sample extrudes well.
1141 Hole 6	Same sample as above. Extruded, de-aired for comparison with hand-moulded briquettes.		06 04 02 1	0.3 0.7 1.7 4.1	12.4 11.2 9.5 3.9	Light red Medium red Fair red Dark red	Fairly hard Fairly hard Hard Steel hard	Extruded column was smooth, dense and strong. C/B ratio at cone 06 is 0.775; at cone 04 is 0.740; at cone 02 is 0.700; at cone 01 is 0.500.

Table II (Cont.)

Clay No.	Unfired Characteristics (of samples ground to - 16 mesh)	P.C.E.	Fired Characteristics: Cone No.	Fired Shrinkage (%)	Absorption (%)	Colour	Hardness	Remarks
1142 Hole 6	Red, calcareous shale; good workability, fairly plastic, water of plasticity 20.9%, safe drying, drying shrinkage 4.9%.	Cone 6 approx. 2194°F	06	0.3	13.8	Light red	Medium soft	Same comments as 1132.
			04	2.0	11.4	Medium red	Medium hard	
			02	3.0	8.3	Red	Hard	
			1	6.5	1.2	Very dark red	Nearly vitrified	
1143 Hole 7	Red, non-calcareous shale; rather good workability, fairly plastic, water of plasticity 20.9%, safe drying, drying shrinkage 5.3%, slightly silty.	Cone 9+ approx. 2310°F	06	1.2	11.5	Light red	Fairly hard	Same comments as 1132.
			04	2.2	9.2	Medium red	Hard	
			02	4.4	6.0	Red	Very hard	
			1	7.0	2.0	Dark red	Nearly vitrified	
1144 Hole 8	Red, calcareous shale, somewhat silty; fairly good workability, fairly low plastic, water of plasticity 20.0%, safe drying, drying shrinkage 4.4%.	Cone 6+ approx. 2200°F	06	+0.1*	13.2	Pale red	Medium soft	Same comments as 1131.
			04	1.0	12.3	Medium red	Fairly hard	
			02	1.5	10.4	Fair red	Hard	
			1	5.0	3.6	Dark red	Steel hard	
1145 Hole 8	Red, calcareous shale, somewhat silty; fair workability and plasticity, water of plasticity 20.3%, safe drying, drying shrinkage 4.8%.	Cone 6+ approx. 2200°F	06	0.2	12.9	Light red	Fairly soft	Same comments as 1131.
			04	1.2	11.6	Medium red	Fairly hard	
			02	1.9	10.0	Fair red	Hard	
			1	4.9	4.3	Dark red	Steel hard	
1146 Hole 10	Red, calcareous shale, somewhat silty; good workability, fairly plastic, water of plasticity 22.3%, safe drying, drying shrinkage 4.5%.	Cone 6+ approx. 2200°F	06	0.2	13.5	Pale red	Fairly soft	Same comments as 1132.
			04	1.2	11.7	Medium red	Fairly hard	
			02	2.3	8.6	Fair red	Hard	
			1	6.2	2.1	Dark red	Nearly vitrified	
1147 Hole 11	Red, non-calcareous shale; good workability and plasticity, water of plasticity 25%, safe drying, drying shrinkage 6.2%.	Cone 6+ approx. 2200°F	06	3.8	8.6	Light red	Hard	Same comments as 1132. Slight tendency to scum.
			04	7.3	3.4	Fair red	Steel hard	
			02	8.5	1.0	Red to dark red	Nearly vitrified	
			1	7.7	0.5	Dark red	Vitrified	

* Plus sign indicates expansion.

Conclusions

The geological investigation of the Bacon Point area, based on coast-line, road-side and drill-hole observations indicates the occurrence of sizeable bodies of 'shale'. Ceramic tests indicate that most of this 'shale' has properties suitable for certain brick and tile products.

The Bacon Point area is serviced by good roads leading northward to Charlottetown and westward to Summerside, distances of 15 and 40 miles respectively. It is only 3 miles by road, however, to Canceaux Point where a small dock formerly served a car and passenger ferry to Charlottetown, 2 miles across the estuary. Transportation of ceramic products to the Island markets therefore would not pose a serious problem. Furthermore, quarrying operations would be facilitated by the excellent drainage conditions that exist along this coast.

The Bacon Point shale area is located on the south shore of the Island and therefore is, unfortunately, not as centrally located as might be desired. The shale layers outcrop on the side of a hill and are mostly well below the level of the main access road, and are close to the sea-cliff. The beds dip inland at about 8 degrees and hence their workable outcrop is limited in a northward direction. Scouring by glacial action has also removed considerable quantities of shale in some favourable sites, with deposition of till in its place. Overburden on the whole, however, is very thin — generally less than 3 feet.

Figure 1 reveals the larger areas of potential shale outcrops. Between drill-holes #2 and #8 shale appears to outcrop over workable widths. Possibly somewhere near holes #3 or #5 would be favourable sites for a bulk ceramic test on several tons of shale. If possible the sample should be taken over a vertical section of 10 feet. If this bulk test gave satisfactory ceramic results then detailed test-drilling or test-pitting might be undertaken to outline the workable area prior to any small scale kiln development. This intermediate step is essential in view of the irregular character of the bedding structures and properties over short distances.

Beds of shale encountered in hole #11 and the upper part of #10 also have favourable ceramic properties. These beds have an indicated thickness of 8 and 20 feet respectively and probably thicken eastward toward Holland Cove. The upper horizon should extend around the valley that leads down to Holland Cove. Both beds might be worth examination by test-pit methods to ascertain their potential for the manufacture of brick and tile.

A shaly horizon of possible interest, but which was not tested in the course of the current project, outcrops along the highway and in the farm lanes on its north side, between the lines of hole #6 and hole #8. This shaly horizon is readily accessible and has good thickness, but the presence of the highway itself and the farm buildings above it mitigates against development at the present time.

The eastward and westward extensions of the shales with Bacon Point area offer the possibility of development for brick-making purposes providing suitable outcrop areas can be located. Though shale is present elsewhere in the central part of Prince Edward Island, it does not appear to be extensive and the trace of the beds has not yet been outlined. Thus, the Bacon Point area is currently the most favourable site for the development of shale for ceramic purposes. The supply of shale is adequate for a small-scale stiff-mud plant, should the demand for brick and tile products warrant production.

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