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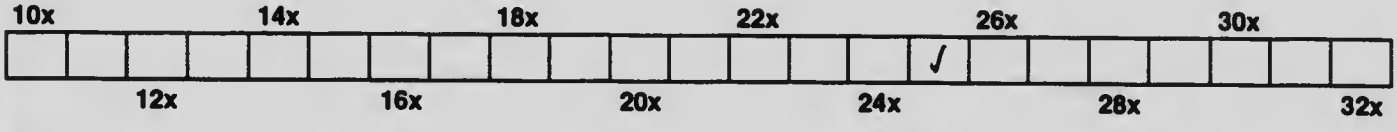

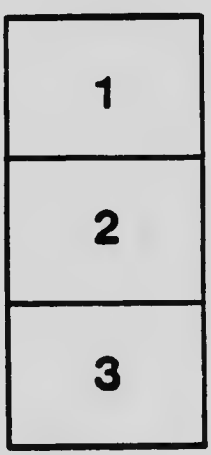

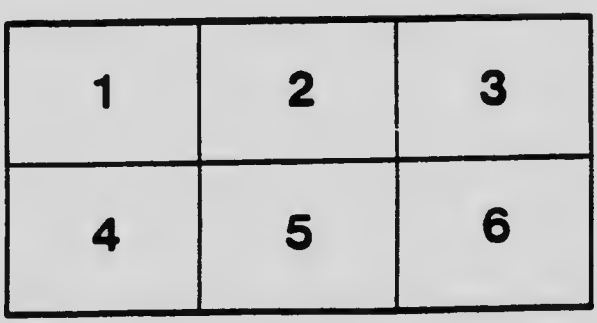

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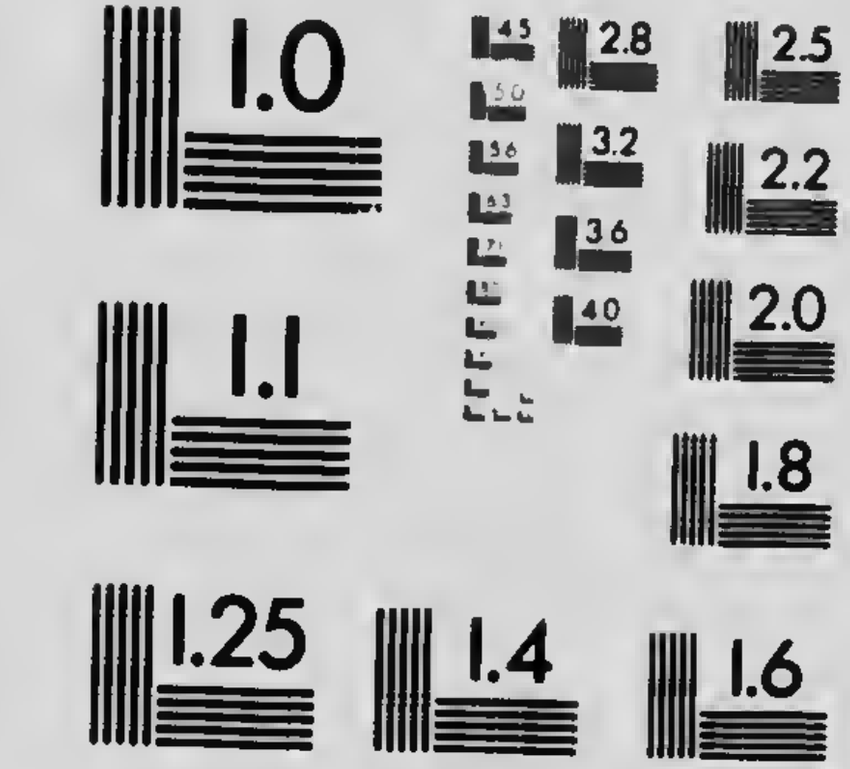

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MINES BRANCH
EUGENE HAANEL, PH.D., DIRECTOR.

BULLETIN No. 10

Notes on Clay Deposits Near McMurray, Alberta

BY
Sydney C. Ells, B. Sc.

OTTAWA
GOVERNMENT PRINTING BUREAU
1915

No. 336

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LETTER OF TRANSMITTAL.

Dr. EUGENE HAANEL,
Director Mines Branch,
Department of Mines,
Ottawa.

Sir,—

I beg to submit, herewith, some notes on certain clay deposits near McMurray, Alberta. The samples referred to in these notes were secured during the course of an investigation of the bituminous sands of the McMurray area.

I have the honour to be, Sir,
Your obedient servant,
(*Signed*) **S. C. Ells.**

OTTAWA, March 31, 1915.

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ON
CLAY DEPOSITS
NEAR McMURRAY, ALBERTA.

By

S. C. Ells.

NOTES
ON
CLAY DEPOSITS
NEAR McMURRAY, ALBERTA.

INTRODUCTORY.

Incidental to the recent investigation of the bituminous sands of Northern Alberta, small samples of clays were secured by the writer at a number of points in the McMurray area during the field season of 1914. In most instances the thickness and extent of individual beds could not be determined without an undue amount of boring and excavation. All the clays referred to, either immediately overlie the Devonian limestone, or are associated with the Dakota sands.

It is considered that the samples secured will indicate, fairly well, the general character of clays in that portion of the area referred to. At the same time it should be remembered that, in work of a purely reconnaissance nature, the samples taken represent only a small percentage of all deposits, and that prospecting of a more detailed nature may discover still other types of clays of economic value.

An excessive percentage of carbon is noted in the case of certain of the samples examined. Where the clay lies between the bituminous sand and the Devonian limestone, this contained carbon has been largely, if not altogether, derived from the overlying bituminous sand. It is probable that such contamination would materially decrease on working in from the outcrop.

In the following notes actual extent and thickness of overburden are not stated. To secure accurate data regarding this very important feature will require further detailed work in the case of each individual deposit. The question of transportation will also require careful consideration.

In considering a possible fuel supply, it may be stated that workable beds of coal have not, as yet, been found in this part of the Province of Alberta. There is, however, a fairly large supply of birch and poplar—chiefly of second growth—along most of the streams. It appears possible that intelligent prospecting may discover fuel gas in commercial quantity.

All the laboratory work necessary for a full series of physical tests, in order to determine the industrial value of the clays, was done by the writer, under the direction of Mr. Joseph Keele, and comments on the results of the tests were written by him.

LOCATION, AND RESULTS OF TESTS OF CLAY SAMPLES.

STEEPBANK RIVER

Steepbank river enters the Athabaska from the east 21·5 miles north of McMurray. Along both sides, frequent exposures of clays were observed throughout a distance of 17 miles from the mouth. Samples 302, 303, and 304 are from points 4·9, 4·2, and 2·3 miles, respectively, from the mouth. A small amount of excavation would uncover other outcrops in addition to those from which the above samples were taken.

The overburden along this stream will, in most instances, be very heavy.

Laboratory No. 302. This is a grey, highly plastic, fine grained clay, requiring 28 per cent of water for tempering. It has good working qualities. The drying shrinkage is 8 per cent. It must be dried slowly to avoid cracking.

On burning to cone 010, a dense, steel-hard body is produced, having an absorption of 10 per cent, and fire shrinkage of 1·3 per cent. If burned to cone 06, the absorption is reduced to 4 per cent, but the fire shrinkage is too high, being 4·6 per cent.

Burning to higher temperatures produces bloating, unless the firing is done very slowly. The clay is intact at cone 3, and will probably stand a much higher temperature, but the presence of carbonaceous matter is a defect, and interferes with the development of a good product.

Laboratory No. 303. This clay is light grey in colour, and rather calcareous. It requires 27 per cent of water for tempering; the working qualities are good; the wet body is fairly smooth and free from coarse grit. The clay can be dried as fast as desired after moulding, the drying shrinkage being 5·8 per cent. The following results were obtained on burning:—

Cone.	*Fire Shrinkage.*	*Absorption.*	*Colour.*
	%	%	
010	0	25	salmon
06	0	25	pink
03	0	23	buff
3	fused		

This clay is suitable for the manufacture of common building brick, either by the stiff mud or soft mud process; but must be burned to cone 03 to secure the best results. It is a typical calcareous brick clay, which is used largely for the manufacture of clay products in many parts of Canada. The buff colour developed in burning is due to the presence of a high percentage of lime.

Laboratory No. 304. This material evidently contains thin bands of limestone interbedded with the clay or shale. The limestone bands are not visible on the weathered outcrops, or in the talus at the foot of the bank, as they soften like the shale.

The numerous white particles seen in the red body of the material, after burning, are lime oxide. These particles will absorb moisture from the air, and, on swelling, break up the burned ware.

In the case of clay No. 303, the lime is in a very finely divided state, and consequently, harmless.

While this clay is not recommended for the manufacture of clay products, it may be useful for Portland cement, if some more limestone is added.

MUSKEG RIVER.

Muskeg river enters the Athabaska 31 miles north of McMurray. Samples 190, and 305, 306, 308, and 309 were taken from points along the lower four miles of its course.

None of the beds from which samples were taken are exposed to a thickness that would warrant commercial development; and a considerable amount of exploration will be necessary to demonstrate their value. In certain instances, however, the thickness of overburden should not prove prohibitive, and transportation to the Athabaska presents no serious difficulties.

Laboratory No. 190. From point on northwest shore of Muskeg river, between head of portage and mouth of river.

A light grey, very plastic clay, with good working and drying qualities. It burns to a cream coloured, dense, steel-hard body at cone 3, with a total shrinkage of 9 per cent, and softens when heated up to the temperature of cone 27. This is a good example of a stoneware clay, and is also a fire-clay. It is the most refractory clay at present known to occur in the province of Alberta.

Laboratory No. 305. Light grey clay.

This clay has good plasticity and working qualities when tempered with 27 per cent of water. It is fairly smooth to the feel, and free from coarse grit. The shrinkage on drying is 8 per cent, and fast drying can be accomplished safely without cracking the ware.

The following results were obtained on burning:—

Cone.	*Fire shrinkage.*	*Absorption.*	*Colour.*
	%	%	
010	0·7	11	light red
06	4·0	4	red
03	4·0	0	dark red
3	begins to soften.		

This is a good, red, burning clay, suitable for the manufacture of rough clay products, such as building brick and hollow block. The shrinkages are rather high, but this would be overcome by adding about 20 per cent of sand. This clay would also be useful for mixing with one of the higher grade clays in this vicinity for the manufacture of vitrified wares.

Laboratory No. 306. This clay requires 37 per cent of water to bring it to a good working consistency. The effect of this large quantity of water is evident in the high drying shrinkage, which is 10 per cent.

A steel-hard, light red body is produced at cone 010, having an absorption of 12 per cent, and a fire shrinkage of 1·3 per cent.

When burned to a higher temperature, the colour is improved, but the fire shrinkage is too high. With the addition of 25 per cent of sand, this clay would be suitable for the manufacture of common brick.

Laboratory No. 308. This is a red burning clay, similar to 306, but the shrinkages are not quite so high. When mixed with 25 per cent of sand and burned to cone 010, a good strong common brick can be made from it.

Laboratory No. 309. This is another red burning clay, similar to 306 and 308, but the shrinkages in drying and burning are less than these.

It burns to a light red, steel-hard, dense body at cone 010, with a total shrinkage of 10 per cent. When mixed with about 25 per cent of sand, it could be used for common brick. It must be burned slowly on account of the carbon it contains. A test piece burned to cone 03 had a black core, and was bloated, owing to this cause.

MCKAY RIVER.

The McKay river enters the Athabaska from the west, some 34 miles north of McMurray. Outcrops of clay were observed along the lower thirty miles of its course.

Samples 310, 311, and 312 were taken at points 11·2, 26·7, and 27·2, miles from the mouth.

Sample No. 311 represents a large deposit, the development of which should present no serious difficulty. Samples 310 and 312 represent deposits regarding the extent of which little can be stated, owing to slide and talus piles. In all three cases transportation to the Athabaska will present considerable difficulty.

Laboratory No. 310. This clay requires 23 per cent of water to bring it to the best working consistency. It is very plastic, and smooth. The drying must be done slowly after moulding, to avoid cracking. The drying shrinkage is about 7 per cent. The results obtained in burning are as follows:—

Cone.	*Fire shrinkage.*	*Absorption.*	*Colour.*
	%	%	
010	0	10	buff
06	1·4	8	"
03	3·0	3	"
1	3·4	2	dark buff
5	2·0	0	grey
15	Fused.		

This is one of the better grades of clay, with good working qualities, and shrinkages within commercial limits. It would be suitable for the manufacture of hard burned fireproofing buff face bricks, or sewer pipe. The drying qualities could be improved by the addition of a small percentage of ground-burned clay to the raw clay. It must be burned slowly.

Laboratory No. 311. This clay requires 26 per cent of water for tempering. It has fairly good working properties, but the wet body is rather short on account of a considerable quantity of fine grained silt being present. It stands fast drying without cracking, after moulding.

Owing to its silty content, this clay has lower shrinkages than any of the red burning clays already described. It will make a good common red brick when burned to cone 010; but the colour and body are improved by burning to cone 06. It is overfired at cone 03.

Laboratory No. 312. This is a low grade, red, burning clay, which has several defects, such as cracking in drying and firing, and excessive shrinkages. It is useless for the manufacture of clay products.

MOOSE RIVER.

The Moose river enters the Athabaska some 47 miles north of McMurray. Outcrops of clay were observed at intervals throughout the distance that this stream was ascended, namely 16 miles.

Samples 187, 191, 313, 314, 315, 316, 316A and 317, were taken at points 6·8, 3·3, 6·75, 6·7, 6·6, 5·6, 2·2, and 1·8 miles, respectively, from the mouth. As elsewhere in the district, slide and talus obscured the greater part of each deposit. The largest single exposure was that from which sample 316 was taken. Here, the clay has an exposed thickness of 16 feet, and an exposed length of 170 feet. What appears to be the same bed of clay re-appears some 700 feet below the outcrop from which sample 315 was taken.

Along the contact between the clay and overlying bituminous sand, fragments of pyrite float up to 15 lbs. in weight, as well as pieces of carbonized wood, were found.

Laboratory No. 187. Dark grey, nearly black clay, underlying bituminous sand.

This clay is very plastic, fine grained, and smooth. It works up rather stiff and slightly sticky. Dries very slowly, with a drying shrinkage of 6·5 per cent. This clay contains such a large percentage of asphaltic carbon, that it is very hard to burn without swelling, unless burned very slowly during the oxidation stage. The density of body, due to the extreme fineness of grain, interferes with the expulsion of carbon, so that the oxidizing process of this clay is tedious.

The clay burns to a light red colour at the lower temperatures, and to a buff or grey at higher. It vitrifies about cone 5, and is fused at cone 20.

This clay is of the stoneware type, but the carbon it contains is a detriment.

Laboratory No. 191. From Moose river, interbedded between bituminous sand and Devonian limestone.

Dark grey, very plastic, smooth, fine grained clay of the stoneware type. Burns to a salmon coloured dense body at cone 3, with rather high shrinkage, and fuses at cone 18.

Laboratory No. 313. This clay only required 14 per cent of water for tempering, owing to the presence of a large percentage of rather fine grained quartz sand. The plasticity and working qualities were low for this reason.

The drying shrinkage was only 3 per cent.

The following results were obtained on burning:—

Cone.	*Fire shrinkage.*	*Absorption*	*Colour.*
	%	%	
010	0	8	salmon
06	0	8	buff
03	0	8	"
5	0	7	"
14	begins to soften		grey
18	fused		

As this clay is too sandy to use alone, a mixture was made by adding 50 per cent of a fat clay (315) from a near-by locality. This gave a body with properties intermediate between the two extremes of a highly plastic clay with large shrinkage, and a lean clay with low shrinkage, so that the results obtained in working and burning were good. The air shrinkage was about 5 per cent. A steel-hard, practically non-absorbent body was produced at cone 1.

This mixture would probably be suitable for sewer pipe, or electrical conduits.

Laboratory No. 314. This is a soft grey clay, with good plasticity and working qualities. Wares moulded from it will stand fast drying without checking.

The drying shrinkage is 6 per cent.

The following data were obtained on burning:—

Cone.	*Fire shrinkage.*	*Absorption.*	*Colour.*
	%	%	
010	0	12	salmon
06	1·0	9	"
03	2·3	5	"
1	3·4	1	buff
5	4·6	0	grey
9	intact		
14	softens		

This is a good material, the shrinkages are low, and it gives no trouble on burning. It would be useful for the manufacture of face brick, fireproofing, electrical conduits or sewer-pipe.

Laboratory No. 315. This is a soft grey clay, very plastic and smooth when tempered with water. It is rather stiff and hard to work, but its working qualities could be improved by the addition of some ground calcined clay, or 'grog' as it is termed in the clay-working industry.

The clay contains a certain amount of carbon, which will give trouble in burning unless this operation is done very slowly. It burns to a dense body at low temperatures, the colours being salmon to grey. It develops fire checks, and becomes brittle at higher temperatures.

Samples of 3-inch, round, hollow tile, were made from this clay, and sent to a commercial sewer-pipe works for salt glazing.

Salt glazing test. This material came from the kiln with a uniform bright salt glaze of a rich light brown colour.

The body was vitrified, but the shrinkage was rather high, showing the necessity for the addition of some coarse material.

The results of this test show that a fine salt glaze can be applied to this clay at cone 3.

Laboratory No. 316. This clay requires 21 per cent of water to bring it to a working consistency. The plasticity is good, and the clay is smooth to the feel.

It must be dried slowly after moulding, as checking may occur if the drying is forced.

The drying shrinkage is 6 per cent, and the following results were obtained on burning:—

Cone.	*Fire shrinkage*	*Absorption.*	*Colour.*
	%	%	
010	1·3	9	salmon
06	2·6	7	"
03	3·7	2	"
1	4·0	0	grey
13	fused		

This clay behaves well at all stages of burning up to cone 1, when it becomes vitrified. When burned to cone 3, the test piece showed blistering on the surface and a honey-combed body, but this may be due to raising the temperature too fast, because the clay does not actually melt until cone 13 is reached.

Laboratory No. 316A. This is a light brown silty clay, with low plasticity, and poor working qualities.

It burns to a porous red body at low temperatures, and melts about cone 3.

The only use this clay would have in the clay-working industry is the production of an indifferent common building brick.

Laboratory No. 317. Light grey clay, with slightly reddish tinge, requiring only 17 per cent of water for tempering. It is rather stiff in working when wet; the plasticity is good, and the clay is very smooth. The drying qualities were not tested, but they are probably good, owing to the small amount of water required to bring it to a working condition.

The drying shrinkage is 5 per cent, and the following results were obtained on burning:—

Cone.	*Fire shrinkage.*	*Absorption.*	*Colour.*
	%	%	
010	0	10	salmon
06	0	10	"
03	1	7	buff
1	1	6	"
5	2	3	grey
9	4	vitrified	"
16	fused.		

This is a stoneware clay suitable for the manufacture of pottery, crocks, jars, teapots, etc. It would require some experimental work to fit the bodies with suitable glazes, but it is probable that the usual Bristol and slip glazes used for stoneware articles would answer.

Some 3-inch, round, hollow tile, was made on a hand press, and sent to a commercial sewer-pipe plant for a salt-glazing test.

Salt glazing test. The results of the salt glaze tests on this clay show that the glaze cannot be successfully applied at cone 3, as that temperature is too low. The body showed no sign of vitrification, being still porous and rather soft.

It would require a temperature in the kiln of at least cone 5, or better, at cone 6 to produce a glaze on this clay. It will then show a glaze equal to number 315, but of lighter colour. The commercial kiln in which the tests were made, did not give a higher temperature than cone 3, hence it was impossible to complete the test on this clay.

ATHABASKA RIVER.

Laboratory No. 318, is from the west bank of the Athabaska river, about 1½ miles south of the Moose river. The clay bed has a thickness of at least 9 feet, and appears to extend for a considerable distance. The overburden includes from 10 to 15 feet of low-grade bituminous sand, but does not appear to be of prohibitive thickness.

This is fine grained, highly plastic, rather sticky clay, requiring 25 per cent of water to bring it to the best working consistency. It must be dried slowly after moulding, to avoid checking. The drying shrinkage is 7·5 per cent.

It burns to a salmon coloured, steel-hard body at cone 010.

This clay contains a certain amount of carbon, which is expelled with difficulty during burning, owing to the fineness of grain and density of body, so that swelling ensues at higher temperatures unless burned very slowly.

Laboratory Nos. 319 and 320, are from the point near which the southerly boundary of the Murphy bituminous-sand claim meets the east shore of the Athabaska river. Owing to slide and talus, the thickness of the clay could not readily be accurately determined, but appears to be quite 20 feet. At the points from which the samples were taken the overburden appears to consist of from 10 to 20 feet of low grade bituminous sand. What appear to be extensions of the same bed re-appear along the river at intervals for one-third of a mile to the south of the point where samples were secured.

Laboratory No. 319. A light grey, highly plastic and smooth clay, with good working properties. It must be dried slowly, being liable to check, if dried too fast. The drying shrinkage is 5·5 per cent.

The following results were obtained on burning:—

Cone.	*Fire shrinkage.*	*Absorption.*	*Colour.*
	%	%	
010	0	11	salmon
06	0	10	"
03	0·6	8	buff
1	1·3	6	buff
5	2·0	5	grey
9	4·0	vitrified	"
17	fused		

This is a typical stoneware clay, suitable for the manufacture of all classes of stoneware articles, and pottery.

It is not a fireclay, but may be sufficiently refractory for stove linings, boiler-setting blocks, or other purposes where extremely high temperatures would not be used.

This is one of the best clays of the series ; it closely resembles No. 317, which is almost as good. It is not so refractory as No. 190, which stands up at the highest temperature of any of these clays.

Laboratory No. 320. A highly plastic rather sticky clay, when wetted, being stiff and hard to work. It requires to be dried slowly after moulding. The shrinkage on drying is 9 per cent, which is rather too great.

It burns to a dull salmon colour and steel-hard body at cone 010. Considerable trouble is experienced when burning this clay at higher temperatures, on account of the carbonaceous matter it contains. It fuses about cone 4. Owing to the carbon, high shrinkage, and low fusibility, this clay is not of much value.

Laboratory No. 321 is from the west bank of the Athabaska river, at a point about 1½ miles north of the mouth of the Calumet. It rests on Devonian limestone, but has no capping of bituminous sand. The exposed face is over 300 feet long, and upwards of 40 feet in thickness. The overburden is relatively light.

This is a light yellow, highly calcareous clay, with rather low plasticity, so that the wet body is short, and crumbly in working.

It burns to a very porous, chalky, buff-coloured body, at cone 03, on account of the high percentage of finely divided lime it contains. This clay has little or no value.

Laboratory No. 188. From east bank of Athabaska river, ½ mile above McMurray, Alberta.

A dark grey clay, exceedingly plastic, and smooth, smelling strongly of asphalt when damp.

It burns to a light red colour at a low temperature, becoming grey when heated up to cone 5, or thereabouts.

It fuses at cone 16.

Owing to its fineness of grain, and to the fact that it contains a certain percentage of asphaltic carbon, this clay is very

hard to burn. It could not be used unless a certain amount of it were calcined, ground, and added to the raw clay. This would improve its working, drying, and burning qualities.

Laboratory No. 189. Mottled, light red clay, from north bank of Firebag river, ¼ mile above first rapid.

This is a very plastic and rather sticky clay. It burns to a red vitrified body at cone 3, but the shrinkages are rather high. It fuses about cone 10. This clay may be suitable for the manufacture of sewer pipe.

Laborotory Nos. 188, 189, 190, and 191 are alike in many of their physical characteristics, and appear to occur in the same geological horizon—viz., underlying the tar sands, on the Athabaska river, and its tributaries. They are very fine grained sediments, and low in fluxing impurities, No. 190 being exceptionally so, hence they are more refractory than any of the Cretaceous clays from the southern part of the Province.

The samples were too small in size to allow of complete determinations concerning their working and drying qualities, but they appear to be free from the drying defects so common to the Western Cretaceous clays.

These clays are of the stoneware type, being exceedingly plastic, and burning to a light-coloured, dense body, at cone 5, while they retain their shape without softening when fired to much higher temperatures. Their most serious defect is due to the presence of asphaltic carbon, which renders the safe burning of wares made from them a difficult process. Nos. 190 and 191 appear to be free from this impurity, as far as could be told from the small samples, and these clays would be valuable for many purposes.

Up to the present time the possible value of the clays of this part of the Province appears to have been quite overlooked by prospectors and others. The results of the above tests are, therefore, of economic interest, since they furnish the first authoritative statement regarding the class of clays to be found in an entirely new area. Given adequate transportation facilities, these results should encourage careful and detailed prospecting for the higher grades of clays in the northern portion of Alberta.

Partial table of pyrometric cones and their melting

Cone	Fusing Points.	
	Degrees C.	Degrees F.
010	950	1742
06	1030	1886
03	1090	1994
1	1150	2102
3	1190	2174
5	1230	2246
9	1310	2390
13	1390	2534
14	1410	2570
15	1430	2606
20	1530	2786
25	1630	2966
26	1650	3002
27	1670	3038