PROVINCE OF ALBERTA
Research Council of Alberta Report No. 61
University of Alberta, Edmonton, Alberta

Clay Deposits of Elkwater Lake Area Alberta

By
M. B. B. Crockford

EDMONTON
PRINTED BY A. SHNITKA, KING'S PRINTER
1951

TABLE OF CONTENTS

CHAPTER I

CHAPTER II

CHAPTER III

CHAPTER IV

APPENDIX I

MAPS AND TABLES

Clay Deposits of the Elkwater Lake Area, Alberta

Chapter I

INTRODUCTION

THE AREA

LOCATION AND ACCESS

The Elkwater Lake area as described herein comprises largely the Cypress Hills area of Alberta. The Cypress hills are a prominent topographical feature in southeastern Alberta and southwestern Saskatchewan. They reach only for about 25 miles westward into Alberta, but extend into Saskatchewan for several times that distance. In Alberta they extend westwards from ranges one to four and lie wholly within township one. Their western extremity is about 35 miles from Medicine Hat. They are about 20 miles south of the main line of the Canadian Pacific Railway.

The area covered by Map 23, which accompanies this report, covers about 500 square miles. Not all that area was prospected for clay however, for activities were largely confined to the Cypress hills.

The map-area is served by a gravelled trunk road, which extends southwards from the eastern end of Elkwater lake, and over the Cypress hills to the international boundary at Wildhorse. Northward this road joins the Trans-Canada highway a few miles west of the town of Irvine. From the gravelled highway many roads branch off, so that almost any part of the Cypress hills may be reached by automobile. They may also be reached by roads that lead southeastwards from Medicine Hat, and either connect with the aforementioned gravelled highway, or else give direct communication to the west end of the Cypress hills. All important roads and trails are indicated on the accompanying map.

PREVIOUS GEOLOGICAL WORK IN THE AREA

The Cypress hills have attracted the attention of geologists from the earliest times. One of the earliest workers was G. M. Dawson who, in 1875, published the accounts of his observations there. He was followed by R. G. McConnell whose report was given in greater detail (McConnell, 1885), and who named some of the rock formations. The economic possibilities of the Whitemud formation in Saskatchewan were studied by N. B. Davis (1918), who is also responsible for some of the formational names found in the geological literature of the Cypress hills. The most complete accounts of their geology are contained in the reports of M. Y. Williams and W. S. Dyer (1930); F. J. Fraser, F. H. McLearn, L. S.

Russell, P. S. Warren, and R. T. D. Wickenden (1935); L. S. Russell and R. W. Landes (1940); and G. M. Furnival (1946). Each of the above workers or group of workers carried out the surveys in more detail than his predecessors, and as a consequence some revisions of formational boundaries and nomenclature were necessary. Since the area covered by G. M. Furnival adjoins the present map-area on the east, rock formations as described in and delimited by his work should extend into Alberta. This was found to be the case in the present survey, and hence the formational boundaries and names as used by Furnival have been adopted in the present report.

In addition to the numerous governmental surveys outlined above, the Cypress hills have been the subject of many detailed stratigraphical and structural surveys conducted by private interests. The object of these investigations was primarily exploration for oil. Information gained by the oil companies has not been published.

PRESENT WORK IN THE AREA

Since the centre of the ceramics industry of Western Canada is situated at Medicine Hat, and since the bulk of the higher quality clays used there are brought from outside the province, it was thought that a survey should be made for the purpose of determining whether commercial clays were available within Alberta, and especially if they were close to Medicine Hat. Moreover, since some of the imported clays are mined in Saskatchewan from a rock formation—the Whitemud—which was known to extend into Alberta, it was thought that this formation offered the best prospects for supplying the local market. Though the Whitemud clays of Saskatchewan have been studied in detail by N. B. Davis (1918), W. G. Worcester (1929), F. H. McLearn and J. F. McMahon (1934), and others, no such surveys have been pursued in the Alberta section of the Cypress hills. Russell alone (1940) had drawn attention to the possibilities of the clays in the Alberta section, for a few clay samples that he had taken along Medicine Lodge coulee and Thelma creek had proven to have a high quality. Consequently the major part of the 1948 field season was spent in examining and sampling the Whitemud formation where it outcrops in the Cypress hills of Alberta. In the course of this survey over one hundred clay samples were taken, most of them from the Whitemud formation, and comparatively few from the Eastend, Ravenscrag and Cypress Hills formations.

Since the Cypress hills had been geologically mapped in considerable detail by both the teams of Williams and Dyer and of Russell and Landes, good stratigraphical control was available for the present survey. The Dunmore map-sheet, No. 597A, by L. S. Russell was especially helpful. Furnival (1946) had shown that some changes in formational names and boundaries were advisable, and hence the map which accompanies this report is a revision of Russell's map, but shows the formational names and boundaries as given in Furnival's Cypress Lake map-sheet which adjoins the

Elkwater Lake map-sheet on the east. A few other changes in formational boundaries necessitated by new information gained during the survey, were made in Map 597A.

The reports and maps of previous workers in this area have been freely consulted in the carrying out of the clay survey. In addition to the reports of the above workers, the writer had the use of aerial photographs for the area. These photographs simplified the work of the survey immeasurably, not only in finding outcrops for examination, but also in locating accurately their geographical position.

It was found during the season's operations that the Whitemud formation has been subject to even more erosion than had been suggested by previous workers in the area. This may account for the difference between Map 23 and those of previous issues. Furthermore, detailed surveys such as the present one and also those carried out by oil companies show that slumping has been very prevalent, and is still more active in the Cypress hills than was formerly supposed. As a result of many observations and studies it was found that extreme caution is required before concluding whether or not certain outcrops are in place.

ACKNOWLEDGMENTS

Capable assistance in the field was given by W. H. A. Clow, assistant geologist, and by P. J. S. Byrne and J. T. Cook, student assistants. Dr. J. A. Allan, at that time head of the Department of Geology, University of Alberta, and also member of the Technical Advisory Council to the Research Council of Alberta, gave support to the investigation in many ways. S. J. Groot, Research Council of Alberta, prepared the map which accompanies the report. The writer extends to the above his appreciation for their assistance.

Preliminary burning tests on the clay samples were made by officers of the Medalta Potteries and of the Medicine Hat Potteries. These officials evinced their interest in the survey in other ways as well and for all such favours gratitude is expressed. The detailed tests of the clays as given in the tables which form part of this report were conducted by Professor W. G. Worcester, University of Saskatchewan, and by Messrs. Ian Wright and R. Shonk of the Bureau of Mines, Ottawa. To these men the writer extends his sincere thanks. Grateful acknowledgment is also made to Messrs. A. S. Dawson, geologist, Canadian Pacific Railway and L. Lindo, instructor in ceramics, Institute of Technology and Art, Calgary, for information and other services rendered.

The writer is indebted to the California Standard Company for a considerable amount of the stratigraphic data included in this report. Much of this information was obtained by the writer while in the employ of that company, which has generously released it for publication.

Chapter II

GENERAL GEOLOGY OF THE AREA

STRATIGRAPHY

INTRODUCTION

The Cypress Hills region, which includes the Elkwater Lake map-area has been surveyed geologically in more or less detail from time to time by governmental agencies, and the results of these surveys have been published. This published information is readily available to those interested, and hence need not be restated in detail here. However, sufficient data to give a clear understanding of the stratigraphy and geological structure of the area are recapitulated here. In addition, the writer has supplemented the observations of previous workers by data gathered from private sources in recent years.

DESCRIPTION OF FORMATIONS

The rock formations which are exposed as bedrock in the map-area and in adjoining territory are summarized in Table A. The distribution of the formations within the map-area is shown in Map 23 which accompanies this report.

Oldman Formation:

This formation consists essentially of alternating beds of freshwater sandstones and shales. The sandstones are usually light grey, and have thicknesses as great as 50 feet or more. Most shales are grey or green in colour, though some are reddish-brown owing to a high content of carbonaceous matter. Some shales are bentonitic, but beds of pure bentonite are rare. The bentonite beds that do occur are usually associated with coal seams and black carbonaceous beds, and probably owe their survival to the volcanic ash having accumulated in the quiet waters necessary for plant growth. On the other hand, ash which fell into disturbed waters was disseminated in the sediments and later formed bentonitic shales and sandstones. At the top of the formation coal seams are present in a zone from 10 to 20 feet thick. This zone is known as the Lethbridge member. Ironstone in the form of stringers and nodules are common. The bones and teeth of vertebrates are plentiful in places. All beds, excepting those comprising the Lethbridge member, are extremely lenticular and do not persist laterally for any great distance. Consequently they are practically useless for mapping geological structure.

The Oldman formation does not outcrop within the map-area, but exposures of the uppermost 50 or more feet are common about the periphery of the Cypress hills. One section, exposed in legal subdivision 7, section 31, township 11, range 2, west of the fourth

TABLE A

TABLE OF FORMATIONS

Group	System	Series	Formation	Character	Thickness—Feet
Cenozoic	Quaternary	Recent and Pleistocene		Soil, gravel, silt, boulder clay, etc.	0-100 or more
	Tertiary	Pliocene or Miocene	Flaxville	Gravels of white, grey and brown quartzite; non-marine	0-50
			Unconformity		
		Oligocene	Cypress Hills	Conglomerate; sandstone; clay; non-marine	50-500
			Unconformity		
		Paleocene	Ravenscrag	Grey sandstone; silt; red and green clay; coal;non-marine	200
Mesozoic	Cretaceous	Upper Cretaceous	Frenchman	Grey, buff-weathering sandstone; non-marine	10-200
			Unconformity		
			Battle	Black, bentonitic shale; silt; volcanic ash; non-marine	0-30
			Whitemud	Light grey, greenish-grey and brown clay; silt; sandstone: non-marine	0-45
			Eastend	Grey sandstone; silt and clay; coal; non-marine	115
			Bearpaw	Dark grey shale; grey sandstone; bentonite; marine	1070
			Oldman	Sandstone; grey to black shale; coal;non-marine	400

meridian, and about one-half mile south of the town of Irvine, is as follows:

	Thickness Feet
Overlying beds—sandstone, with included shale fragments, worm tubes (?) one inch in diameter (basal Bearpaw sandstone).	
Oldman Formation	
Shale, reddish-brown, to dark brown and black, coaly streaks in upper part (Lethbridge member)	9.7
Shale, bentonitic, abundant selenite crystals	1.0
Sandstone, silty, thin clay streaks, grades into shale above, brownish-grey	4.5
Shale, carbonaceous, reddish-brown	0.8
Shale, grey, fine flaky	1.7
Shale, carbonaceous, reddish-brown, abundant large selenite crystals	2.8
Shale, weathers light reddish-brown owing to presence of abundant plant fragments, highly bentonitic in upper 0.2 feet	6.0
Shale, grey, weathers fine flaky	3.2
Sandstone, light rusty weathering, clay streaks, few plant fragments	1.5
Shale, sandy streaks at bottom	4.7
Sandstone, tough, coaly on bedding planes, shaly streaks towards top	7.8
Shale, carbonaceous, becoming black and coaly at top	2.2
Shale, grey, blocky	4.5
Shale, reddish-brown, abundant plant fragments	1.0
Silt, pale grey, yellowish weathering	3.2
Shale, brown, plant fragments	3.2
Shale, very carbonaceous, dark brown	0.8
Sandstone, yellowish weathering, friable, becomes shaly with plant fragments in upper foot, base concealed	3.0
Total Oldman beds	61.6

A noteworthy feature of the above stratigraphic section is the abundance of carbonaceous beds in it. This relative abundance characterizes the top of the formation in these parts. It is also to be noted that the Oldman-Bearpaw contact is very abrupt. This sharp break is suggestive of an unconformity, for in some places it appears that the Lethbridge member has suffered some erosion prior to deposition of the Bearpaw formation, and in some other places the member is entirely absent.

Another interesting section of Oldman beds was examined south of the Cypress hills in legal subdivision 3, section 35, township 4, range 5, west of the fourth meridian. The section is as follows:

	Thickness Feet
Overlying beds——sandstone, grey, with rusty yellow weathering inclusions of shale (basal Bearpaw sandstone)	1.3
Oldman Formation	
Shale, carbonaceous, sandy, weathers purplish-brown	2.8
Bentonite, white (dry)	1.0
Tuff (?), chalk-white, indurated, earthy lustre, specks of black mica	0.5
Shale, carbonaceous, with three coal seams up to one foot each in thickness	9.0
Shale, grey, very fine flakes	7.8
Shale, carbonaceous (base of Lethbridge member)	7.5
Shale, grey	6.8
Shale, carbonaceous, brown	1.0
Shale, grey	2.8
Sandstone, light grey, tough	3.4

	Thickness Feet
Shale, dark grey, plant fragments	5.5
Shale, carbonaceous, fissile	1.6
Shale, grey	10.7
Shale, carbonaceous, reddish-brown	0.8
Sandstone, medium to dark grey, irregularly bedded, thin lenses of purplish weathering ironstone	21.0
Sandstone, light grey, tough	5.5
Total Oldman beds exposed	87.7

In the above section the Lethbridge member is 28.6 feet thick, and contains coal seams that were formerly mined for the local market.

The thickness of the Oldman formation in the Elkwater Lake area is estimated to be about 500 feet. This figure is an average of the calculated thickness of 600 feet for the area south of the Cypress hills, and that of 425 feet north of these hills in the vicinity of Irvine.

No clay samples were collected from the Oldman formation, since none of the shales observed appeared to have a pottery grade. Shales suitable for face brick are undoubtedly present, since the same formation furnishes face-brick type shales for the brick plants at Medicine Hat and Redcliff.

Bearpaw Formation:

This is an important formation in southeastern Alberta since it is bedrock in large areas, and since it possesses lithological and fossil horizons which can be used in mapping geological structure. In Alberta the formation forms a belt 15 to 30 miles wide surrounding the Cypress hills. Its outcrops are very abundant in this belt, and in places it has been eroded to form bad land areas which cover many square miles of the region. In many places its contact with the underlying Oldman formation is exposed and fairly complete composite sections of the formation can be compiled.

The Bearpaw formation is composed essentially of marine shales, bentonite beds, and marine sandstone. The shale is dark grey to chocolate brown in colour, is silty in places, and generally weathers into small flakes or angular fragments. Beds of bentonite are common, being especially abundant in the bottom few hundred feet. One of the bentonite beds is especially worthy of mention on account of its thickness and great lateral extent. This bed occurs just 100 feet above the base of the formation, and has a thickness of two to ten feet. It was traced throughout almost the whole periphery of the Bearpaw outcrop in Alberta, and consequently is a very useful marker bed. Some of the bentonite beds higher in the formation have aragonite associated with them.

The sandstones of the Bearpaw formation are fine-grained to medium-grained, and are often glauconitic. Induration of the beds varies considerably, for some are loosely cemented whereas others

are hard and resistant. The sandstone at the base of the formation varies in thickness from a few inches to several feet. Three thick sandstone beds occur in the upper part of the formation, and are well exposed in Medicine Lodge coulee. These have been named the Oxarart, Belanger and Thelma members by Furnival (1946).

A composite section of the Bearpaw formation is given below. Details for the base of the section were obtained along Ross creek south of Irvine, and for the upper part in Medicine Lodge coulee. Localities south of the Cypress hills supplied most of the remaining data.

Overlying beds—sandstone, light grey, fine-grained to medium-grained (basal Eastend sandstone).

	Thickness Feet
Contact conformable	
Bearpaw Formation	
Shale, dark grey with greenish cast, flaky, thin bands of sandstone one inch to two inches thick about one foot apart	10.0
Shale, dark brownish-grey, taking on a greenish tint near the top, flaky	71.5
Coal, with carbonaceous shale at top and bottom, sandy at the base	2.6
Sandstone, fine-grained to medium-grained, pale grey; occasional thin shale band; Thelma member	41.0
Shale, dark grey, silty, few specks of carbonaceous matter, finely micaceous; few thin sandstone bands	14.8
Sandstone, and shale interbedded, with a few streaks of bright green, glauconitic sand	3.2
Sandstone, fine-grained, silty, friable, weakly cross-bedded to finely laminated; many inclusions of shale fragments; large fossiliferous, ironstone concretions 6 feet above base; Belanger member	20.6
Siltstone, shaly, friable	6.2
Shale, grey-brown, slightly silty, becoming more so at the top	19.6
Bentonite, pale grey, stained yellow at top and bottom	0.2
Shale, medium grey, silty	1.4
Coal and black carbonaceous shale	0.7
Shale, dark grey to brownish; carbonaceous in places near base; flaky	3.2
Sandstone, fine-grained to coarse-grained, fairly well indurated with lenticular hard bands, grey when fresh, but weathers buff; massive and cliff-forming; contains *Halymenites major* at the top; often overlain by coal or black carbonaceous shale; Oxarart member	120.0
Sandstone, grey, fine-grained; irregularly interbedded with dark grey and brown silt	7.5
Shale and sandstone, interbedded; sandstone comprises about one-quarter of the interval	23.5
Shale, dark grey and brown, silty, firm and blocky, weathering light brown	4.0
Shale, slightly carbonaceous	0.5
Shale, dark grey to dull brown	13.5
Shale, brown weathering, concretionary	0.5
Shale, dark grey, bentonitic, flaky, weathers brownish	7.0
Shale, dark grey	36.5
Shale, dark grey, weathers into fine flakes	14.0
Shale, dark grey, flaky, concretions about one foot in diameter at top	67.0
Shale, concretions at top	43.0
Bentonite and aragonite	0.5
Shale, grey	12.8
Bentonite, yellowish	0.5
Shale, grey	3.2
Bentonite	0.2
Shale, grey	11.5
Bentonite, grey-green, clayey	0.2
Shale, grey	2.2
Bentonite, yellowish	0.2

	Thickness Feet
Shale, grey	9.7
Bentonite, yellowish, rusty weathering	0.3
Shale, grey	13.5
Bentonite, rusty weathering, with aragonite	0.4
Shale, grey	15.5
Bentonite	0.2
Shale, grey	1.4
Bentonite, cream coloured, rusty weathering	0.5
Shale, grey	7.6
Bentonite, orange brown to rusty red colour, with large selenite crystals	0.3
Shale, dark grey, flaky	15.3
Aragonite with thin bentonite	0.3
Shale, dark grey, flaky	43.0
Shale, grey, silty, compact, cliff-forming	10.0
Bentonite, with aragonite, clayey, rusty coloured	0.3
Shale, grey, silty	3.9
Bentonite, clayey	0.05
Shale, grey	8.7
Bentonite, clayey, brownish	0.05
Shale, silty	4.5
Bentonite, clayey, brownish	0.05
Shale, light brownish-grey, silty, *Baculites compressus* very abundant in upper 40 feet, two parallel rows of concretions at top; few *Placenticeras meeki* present; *Inoceramus sagensis*, *Inoceramus* sp. indet., *Mactra* sp. indet., occur sparingly at this horizon	60.0
Aragonite, cone-in-cone, bentonite	0.3
Shale, grey, silty	21.0
Bentonite, with a development of aragonite here and there; light greenish-yellow; base of aragonite zone	0.2
Shale, silty, blocky weathering in places, medium grey, brownish on fractured surfaces	2.3
Bentonite, with intermittent development of aragonite	0.2
Shale, as above 2.3-foot bed	37.0
Bentonite, buff	0.1
Shale, dark grey	13.0
Bentonite, yellowish-green	1.0
Shale, grey, large nodules in some places	7.0
Bentonite, bright green at base, becoming duller above, and grading into grey shale; volcanic ash in some places	1.1
Shale, dark grey	3.0
Bentonite, greenish-yellow	0.1
Shale, few *Placenticeras meeki*	27.0
Bentonite, greenish-grey	0.3
Shale, large barren concretions to 3 feet in diameter at base	15.0
Bentonite, grey-green, clayey	0.3
Shale, dark grey, abundant *Placenticeras meeki*, *P. intercalare* near base becoming less plentiful above; *Baculites compressus*, *Callista deweyi*, *Lucina occidentalis*, *Protocardia borealis*, *P. subquadrata*, *Vanikoropsis tuomeyana* also present	32.0
Bentonite, clayey, dull green	0.2
Shale, dark grey, flaky	3.7
Sandstone, light grey yellowish weathering, argillaceous fine-grained, contains an abundance of *Arctica ovata*, and occasionally other fossils	2.0
Shale, dark grey	8.0
Bentonite, clayey, dull green	0.3
Shale, dark grey, with large, brown weathering, spheroidal concretions as much as 10 feet in diameter at base of bed, and always found associated with the underlying bentonite bed; concretions contain some fossils, the following being identified in them: *Pteria nebrascana*, *P. linguiforma*, *Volsella attenuata*, *Protocardia borealis*, *P. subquadrata*, and *Placeniticeras meeki*	41.0

	Thickness Feet
Bentonite, green and grey-green, often with intercalated volcanic ash; usually stands out as a prominent white band; gradational into shale above	5.0
Shale, medium grey, silty, tough, cliff-forming	28.0
Bentonite, greyish-green	0.9
Shale, dark grey, flaky	4.0
Bentonite, dull greenish-grey	0.7
Shale, dark grey, flaky, occasional *Placenticeras meeki*	14.0
Bentonite, dull creamy white	0.4
Shale, dark grey	6.0
Sandstone, light brownish-grey, shells of *Ostrea patina* present, some encrusted with selenite	10.0
Shale, dark grey, with small angular fragments of dark grey, silty concretions scattered in it	12.0
Sandstone, brownish-grey, fine-grained, friable, sometimes fragments of *Ostrea patina* present; this sand not always present	12.0
Shale, brownish-grey	11.0
Shale, dark chocolate brown, with inclusions of yellowish sandstone, which almost invariable has worm tubes one-sixteenth to 3/4 of an inch in diameter; basal Bearpaw sandstone	1.0
Total thickness Bearpaw beds	1070.0

Minor unconformity

Underlying beds—shale, reddish-brown, to dark brown and black, thin streaks of coal in upper part, (Lethbridge member of the Oldman formation).

The above composite section includes beds which were placed by Russell (1940) in the Eastend formation, but which on account of their similarity to Bearpaw lithology are now included in this latter formation (Furnival, 1946). The thickness of 1,070 feet may be considered reasonably accurate since good control for the part below the Oxarart sandstone was furnished by a test hole drilled on the north side of the Cypress hills. This hole commenced near the top of the Oxarart sandstone member and supplied data which showed the top of that member to be 875 feet above the base of the Bearpaw formation. As the remainder of the section was measured in place in Medicine Lodge coulee, there is little room for error in arriving at the figure for the total thickness. Close agreement with this figure was obtained by F. G. Lines (1945) who worked independently of the writer in the same general area.

The Oxarart sandstone member outcrops frequently on the west and north slopes of the Cypress hills, and hence has some importance in geological mapping and in structural studies of the area. It is frequently associated with springs which often issue from its base, and may serve to denote the presence of the member.

Fossils, where found in the formation, occur abundantly and in zones. However, their occurrence is sporadic, and none of the zones appears to be continuous, so that frequently the stratigraphic position of certain beds can best be determined by their lithological characteristics.

The Bearpaw formation has not yielded materials of economic importance. It consists largely of shales, but they do not appear

suitable for use in ceramics. The few samples that were taken and tested, though showing a good colour for brick, scummed badly. The scumming could possibly be prevented by treatment. The formation has good possibilities as a source of bentonite. It contains many beds of that material, and some may have the properties required for its use in industry, especially as a constituent of the drilling mud used in the oil industry. Some samples were collected and given preliminary tests for this purpose. It is reported that the bentonite lacked sufficient colloidal properties for drilling mud. However, bentonite more suited to this purpose may be present, and may be revealed by a systematic survey; for it was observed in previous surveys that the bentonites had varying amounts of volcanic ash associated with them.

Eastend Formation:

The beds comprising this formation are brackish and fresh water sandstones, silts, shales along with carbonaceous and coaly beds. These beds form a transitional series between the marine Bearpaw and freshwater Whitemud beds. The formational boundaries are those as delimited by Furnival (1946), and not as initially described by Russell (1940). Outcrops of the formation are numerous in the Cypress hills, especially in Medicine Lodge coulee. The following detailed section of the formation is a composite, being a combination of the beds which occcur at two adjacent localities in legal subdivisions 1 and 8, section 31, township 7, range 3, west of the fourth meridian. Correlation of the two stratigraphic sections is perfect, so that the section may be considered as complete and representative of the formation in this area.

Overlying beds—silt, sandy, kaolinitic (Basal Whitemud beds).

	Thickness Feet
Contact conformable	
Eastend Formation	
Sandstone, fine-grained, silty, yellow at top	6.6
Shale, dull green ,bentonitic	2.5
Sandstone, fine-grained, silty ,grey	3.6
Shale, grey	1.0
Shale, brown, abundant plant fragments	2.5
Shale, grey-brown	1.7
Sandstone, weathers yellowish, fine-grained	26.3
Shale, grey	1.0
Shale, carbonaceous, coaly black	0.7
Shale, dark grey	0.5
Silt, pale grey, fine sandy	2.4
Shale, grey	1.0
Bentonite, light brown	0.1
Shale, dark grey	2.7
Shale, brown, abundant plant fragments, becoming dark brown and bentonitic near top	2.3
Shale, light grey, silty	3.0
Sandstone, silty at bottom, fine-grained, weathers yellowish	5.4
Coal	0.1
Shale, grey	1.0
Shale, carbonaceous, with 1.0′ coal and 0.3′ brown bentonite very close to top	3.5
Shale, greyish-brown at top	3.5
Siltstone, light grey	2.2

	Thickness Feet
Shale, carbonaceous, brown	0.8
Shale, dark brown	0.5
Silt, light grey	0.2
Shale, dark brown below, becoming dark grey and silty above	5.5
Shale, carbonaceous, brown-black, bentonitic at top	1.7
Bentonite, impure, greenish-grey	0.4
Shale, carbonaceous	1.3
Concealed	10.0
Sandstone, light grey, medium-grained, imperfectly indurated in places, 0.2-foot shale parting near base; basal Eastend sandstone	22.0
Total Eastend beds	116.0

Underlying beds—shale, dark brownish-grey, flaky, typical Bearpaw with sandy streaks 1 inch to 2 inches thick about 1 foot apart (uppermost Bearpaw beds).

The economic importance of the Eastend formation is confined to coal. At times a mine has operated at Elkwater lake, where a seam 3.2 feet thick is mined. No clays of possible pottery rank were observed in any of the outcrops examined. The formation does, however, offer good possibilities for face brick and tile clays.

Whitemud Formation:

McLearn (1933) divided the Whitemud formation into four zones which, in ascending order, are: No. 1, white, sandy clay zone; No. 2, brown shale zone; No. 3, white clay zone; No. 4, dark shale zone. Furnival (1946) has given formational status to the No. 4 zone, calling it the Battle formation, and leaving the other three zones in the Whitemud. Furnival's revision is followed in this report.

Wherever beds of this formation outcrop they tend to be conspicious, since some beds are light grey to white in colour, and also since the formation often occurs high up on the bare sides of the valley. The beds comprising the formation consist of sandstones, silts, clays and shales. The beds are for the most part relatively thin, varying from a few inches to five or six feet in thickness. Individual beds do not persist laterally for any great distance, so that the sequence of beds, especially the upper ones, usually differ from outcrop to outcrop. Groups of beds, though, are persistent, and it was observed that, in general, the light coloured clay and kaolinitic beds occur in the upper part of the formation, and that the lower part consists of grey-green shales and light grey, feldspathic sandy beds.

All occurrences of the Whitemud formation in Alberta as shown on previously published geological maps or as indicated on aerial photographs were examined in detail. These occurrences are shown on Map 23 which accompanies this report; and it will be noted that they are grouped about the following centres: Graburn gap, Fly lake, Medicine Lodge coulee, Eagle butte and Thelma creek. The formation is thought to be present a few miles south of Fox Post Office, but the overburden there proved too thick to

be penetrated by the tools at hand. One notable absence of outcrops of Whitemud beds is on the northern slopes of the Cypress hills; and in the vicinity of Elkwater lake there is definite evidence of their complete removal by erosion. There is no doubt that Whitemud beds are more extensive than herein mapped, but they are concealed in many places by the dense forest cover, the slumping and flowing of overlying beds, and the varying thicknesses of wash. The drilling of shallow test holes could be easily employed to delimit the formation.

The mapping of the Whitemud formation is not only attended by the uncertainty of its presence in some areas but also by a further complication, namely, by the presence of slump blocks of these beds far down the slopes and some distance from their original position. Consequently, on some maps the formation is shown to have a greater extent than is actually the case.

The thickness of the formation varies from zero to about 25 feet, and it averages about 20 feet. In some parts the formation is absent, having been completely eroded, and consequently Frenchman sandstone rests upon Eastend beds. In some instances only part of the formation has been eroded so that Frenchman sandstone rests upon lower Whitemud beds.

Complete stratigraphic sections of the Whitemud formation are numerous, and since they are given in detail in the following chapter they need not be recorded here. The most complete sections are exposed at the west end of the Cypress hills. Well exposed, complete sections of the formation were observed at localities 10, 14, 16, 19, 27 and 29 to which the reader is referred for details.

The source of the Whitemud sediments and a satisfactory theory for the formation of the refractory clays have been enunciated by McLearn (1929). McLearn places the source of the Whitemud sediments in a land mass west of the present site of the Rocky Mountains. These sediments, consisting of clays, silts and sands rich in feldspar, were borne eastward by streams, and were deposited on flood plains and deltas. There they were worked, reworked, and redeposited, meanwhile undergoing chemical alteration by weathering. The feldspathic sands were especially beneficial for, by their alteration, kaolin was produced. Redeposition of the sediments involved a certain amount of resorting of the clays, silts, and sands; as a result, refractory clays were deposited in beds of varying thickness and lateral extent. It is supposed that weathering and deposition of the sediments took place in a warm humid climate.

The Whitemud formation in Alberta has considerable importance as a potential source of pottery and other high grade clays. It also has an abundance of clays suitable for making an excellent face brick and other structural products, terra cotta, etc. Clay occurrences of economic significance are considered in Chapter III.

Battle Formation:

This formation consists of dark brown to black bentonitic shale, with intercalated beds of indurated tuff. It varies in thickness from zero to 20 feet or more, depending upon the amount of erosion it had undergone before deposition of the Frenchman formation. Wherever the Battle-Frenchman contact was observed, the change from black Battle shales to brown Frenchman sandstone was abrupt. Though apparently conformable with the Whitemud formation, the contact with it is sharp.

The Battle formation has been correlated with a similar black shale and included tuff in the Edmonton formation of the Red Deer River area (Sanderson, 1945; Furnival, 1946). The widespread occurrence of the shale suggests a marine origin, and samples of the Battle formation were taken in order to examine them for a microfauna. No such fossils were found in the few samples submitted. It is possible that samples taken at widely scattered points may show that the formation was deposited under marine conditions.

Shale samples of the Battle formation were collected, but were found to have no value in the ceramic industry. They contain so much bentonite that cracking and shrinkage are excessive.

Frenchman Formation:

This formation was named by Furnival in 1946 for sandstones and minor amounts of silt and shale which were formerly known as the Lower Ravenscrag. The Frenchman formation is uppermost Upper Cretaceous in age, and the Ravenscrag as restricted by Furnival is Lowermost Paleocene. No complete section of the Frenchman formation was observed in the map-area. The thickest section outcropping occurs along the road that leads up the hill south of Elkwater lake. This section is as follows:

	Thickness Feet
Overlying beds—quartzite pebbles and cobbles (reworked Cypress hills conglomerate).	
Erosion Surface	
Frenchman Formation	
Sandstone, light grey, medium-grained to coarse-grained, crossbedded, large sandstone concretions up to six feet across; upper surface eroded	31.0
Sandstone, light grey, with irregularly shaped lenses of clay galls, the latter from one-quarter inch to two inches across; contains shale and sandstone fragments as well as occasional fragments of petrified wood	2.0
Sandstone, light grey, medium-grained to coarse-grained, crossbedded, indurated lenses about one and one-half feet thick erratically distributed throughout	34.0
Sandstone, crossbedded, some beds stained rusty brown light grey, medium-grained to coarse-grained	22.0
Covered interval	23.0
Sandstone, rusty brown colour, medium-grained to coarse-grained; contains small pellets of sandstone cemented by limonite	2.0

Covered interval	29.0
Sandstone, stained rusty yellow in places, few thin partings of green shale, numerous clay galls, micaceous, argillaceous streaks near top, fine-grained to medium-grained	61.0
Total Frenchman beds	204.0

Underlying beds—shale, brownish-green (uppermost Eastend beds)

The above stratigraphic section is not complete since an unknown thickness of beds has here been eroded from the top of the formation. However the thickness of beds removed is considered small, possibly of the order of 25 to 50 feet. The formation is known to thicken from east to west in Saskatchewan, and to approach 200 feet in thickness near the eastern Alberta border. Since 204 feet of the beds are known to be present at Elkwater lake, a total formational thickness of 225 feet may be safely assumed; even a 250-foot thickness may not be an excessive figure, for silts and shales occur at the top of the formation in Saskatchewan but, if present, are not exposed in Alberta. The thickness can be expected to vary considerably from place to place since the formation was deposited upon a surface rendered uneven by erosion.

The Frenchman formation outcrops frequently about the upper margin of the Cypress hills. The lower contact was frequently observed, but the upper contact, and in fact most of the formation, is everywhere concealed by slumped beds or by vegetation.

This formation has no economic importance in Alberta.

Ravenscrag Formation:

This formation consists essentially of brown, green, grey and maroon shales, sandy shales, grey silts and silty sands. Outcrops of the beds are so few and scattered in the Elkwater lake map-area that no composite section of the formation could be attempted. Russell (1940) assigns a thickness of 560 feet to the Ravenscrag, which at that time included all beds from the top of the Battle to the base of the Cypress Hills formation. If 225 to 250 feet be allowed for the Frenchman formation, the thickness of the Ravenscrag (as defined by Furnival and as used in this report) would be 310 to 335 feet. These figures may vary considerably since the lower contact is often difficult to place, and since the upper contact is an erosional surface.

Wherever observed in the present surveys, Ravenscrag strata consist of thin-bedded, grey, green and maroon shales. Fairly good exposures of the formation are to be found in road cuts on the south side of the Cypress hills along the new highway. Beds were sampled in a few places, and tests of the samples show them to have a doubtful value in the ceramic industry. Some of the clays are highly calcareous.

Cypress Hills Formation:

The Cypress Hills formation consists chiefly of a conglomerate, with interbedded coarse sandstone. The conglomerate is

composed of pebbles, cobbles and boulders of quartzite from one-half inch to 12 inches across. It lies unconformably upon the Ravenscrag. The thickness of the formation is variable since the uppermost beds have been eroded. In section 9, township 8, range 3, west of the fourth meridian, a section of 46 feet of conglomerate was observed.

Flaxville Formation:

This formation is composed of gravels consisting of white, grey and brown quartzite. The gravels are found strewn about on Oldman, Bearpaw and younger formations in the general Cypress Hills region. The gravels are quite thin for the most part, though thicknesses of 50 feet or more have been reported. They were deposited on the Flaxville plain during a second uplift of the Rocky Mountains which occurred in late miocene or early Pliocene time. This plain was from 1,000 to 1,500 feet lower than the Oligocene (Cypress Hills) plain.

STRUCTURAL GEOLOGY

REGIONAL STRUCTURE

The controlling structural feature of south central and southeastern Alberta is the Sweetgrass arch. This feature arises in the Little Belt Mountains of Montana, which are about 110 miles south of the international boundary. It plunges northward bearing subsidiary structures, some of which have a reversal of dip, thereby producing large domes. The Kevin-Sunburst dome is one of the most northerly of these structures, and has its apex about 20 miles south of the international boundary, and slightly east of Coutts. The northern plunge of the Sweetgrass arch is interrupted a few miles south of the boundary by the laccolithic intrusions of the Sweetgrass hills. There local doming occurs. At the international boundary the strata dip northward at about 50 feet to the mile. This dip decreases northwards, being about 35 feet to the mile in the vicinity of Manyberries and about 25 feet northeast of there in the Elkwater Lake area. North of the map-area dips gradually decrease, and are from 5 to 10 feet to the mile north of the town of Irvine.

In Alberta the Sweetgrass arch is asymmetrical, being steeper on the west flank than on the east. Numerous secondary folds have been developed on the flanks of the arch, and have axes which appear to radiate from the main structural axis.

LOCAL STRUCTURE

An anticlinal structure for the Cypress hills has been postulated by many workers in the area. However, this conclusion is not indicated by detailed structural surveys conducted in recent years in the Hills and its adjoining areas; for in the areas south, west and north of the Hills the regional dip to the northeast continues without apparent interruption. In many places surface control is scanty or lacking entirely, but sufficient data were obtained to

suggest that no major reversal to the regional northeast dip is present in the vicinity of the Cypress hills in Alberta. It should be mentioned that from the several structural surveys in the Hills different structural pictures have emerged. This lack of agreement may be largely attributed to the tendency of many beds to slump. The slumped nature of many outcrops is so well concealed that it is often impossible to detect it, and hence erroneous conclusions are often reached regarding local structure. Faults of considerable displacement are indicated by certain data obtained in the drilling of a few deep wells in and adjacent to the Hills. However, there is as yet insufficient information to definitely demonstrate their presence. It appears that the true structure of the Cypress hills will only be determined when sufficient deep wells have been drilled on them to supply the evidence.

Strata within the Elkwater Lake map-area dip to the northeast at about 25 to 30 feet per mile. These dips are so low that the beds appear flat, and instrumental surveys are required to determine the amount and direction of dip. For all purposes of mining or quarrying the strata may be considered as flat-lying. If casual observation shows any strata to be inclined, then it is a safe conclusion that they have slumped.

Chapter III

ECONOMIC GEOLOGY

INTRODUCTION

The principal mineral deposits of economic importance in the Cypress Hills area, as evidenced by surface geological surveys, are coal, quartzite pebbles, volcanic ash, bentonite, and clay. Natural gas and oil may be present in commercial quantities, but to date drilling has revealed only shows of either. Since all of the above materials excepting clay have been considered elsewhere (Williams and Dyer, 1930; Russell and Landes, 1940; Furnival, 1946), they will be considered here simply to bring information regarding them up to date.

COAL

Coal has been mined in the vicinity of Elkwater lake for many years. It supplied only the local rural market. At the time of the writer's visit, the only mine recently operated, located in legal subdivision 10, section 23, township 8, range 3, west of the fourth meridian, was shut down. The seam occurs near the base of the Eastend formation, in a coal zone which appears to support only one minable seam. This seam has been burned out in many places along the northern and western edge of the Cypress hills, and its former presence is denoted by shales which have been burned brick red, and by a thin bed of ashes.

QUARTZITE PEBBLES

There is a steady demand for quartzite pebbles for use in the ball mills of British Columbia. The pebbles are collected from the stream beds and transported by truck to the railway for shipment. The source of the pebbles is the Cypress Hills formation.

VOLCANIC ASH AND BENTONITE

Beds of volcanic ash and bentonite occur in the outer periphery of the Cypress hills. The thickest beds observed occur near the base of the Bearpaw formation. The most prominent and persistent bed is one having a thickness of as much as 10 feet, and occupying a position 100 feet above the base of the formation. The bed consists of intercalated volcanic ash and bentonite. In the course of structural surveys the writer has traced this bed from Manyberries to Irvine, a distance of about 75 miles. It has its greatest development immediately south of the latter town. These towns lie about 20 miles southeast and north of the map-area respectively.

Beds of poorly consolidated volcanic ash and bentonite occur at the top of the Oldman formation within the Lethbridge member in the vicinity of Manyberries.

The volcanic ash and bentonite are usually associated in the same bed, and in many places are gradational into each other. No survey has been made of these materials, so their potentialities are as yet unknown. A few samples of bentonite were given very elementary tests for use in drilling mud, but were found to be deficient in certain desirable qualities. It is possible that a systematic program of sampling the known occurrences might reveal deposits of economic value.

No occurrences of possible commercial value were observed within the map-area.

NATURAL GAS AND OIL

The Cypress hills have attracted the attention of oil seekers for several decades. Though results of their explorations have been encouraging, little drilling has followed intensive field studies.

Two wells, both at Eagle butte, have been drilled on the Alberta side of the Cypress hills, but neither found oil or gas in commercial quantities. One of the wells, Eagle Butte No. 1, located in legal subdivision 9, section 31, township 7, range 4, west of the fourth meridian, obtained some encouragement by striking a very large flow of gas in the Lower Cretaceous. The flow turned to water in about 24 hours. This gas horizon was not present in Eagle Butte No. 2 well, drilled in legal subdivision 4, section 30, township 7, range 3, west of the fourth meridian, about six miles east of No. 1 well.

CLAY

GENERAL STATEMENT

Clay deposits of proven and possible economic value occur throughout the length of the Cypress hills, both in Saskatchewan and Alberta. The Saskatchewan clays have been studied in detail, and they alone are used in the ceramic industry. A large quantity of these clays is brought into Alberta for use in the pottery industry, centred in Medicine Hat. Clays of equal quality to many of the Saskatchewan clays have been found on the Alberta side of the Cypress hills, and some may be utilized wherever the many exacting conditions of winning, transportation, and processing permit.

PROCEDURE OF TAKING SAMPLES

Since the Whitemud clays have proven to be the most valuable in Saskatchewan, special attention was given to the Whitemud formation in Alberta during the present survey. Clays from other rock formations were not ignored if they appeared to warrant consideration for use in making pottery. Little attention was given to brick clays, since the present high cost of transporting them to processing plants would prohibit their utilization. Wherever clays of seemingly high grade were observed the stratigraphic section containing them, as well as the overburden, was measured. Samples of the most promising beds were examined and clay samples ob-

tained. Descriptions of these occurrences and results of the tests of the clays sampled are given below. The occurrences are given in order, working westwards from the Alberta-Saskatchewan border along the northern escarpment of the Cypress hills to Eagle butte, from thence southwards through Medicine Lodge coulee, and finally eastwards to the Alberta-Saskatchewan boundary again.

The procedure adhered to in securing a clay sample was as follows. The rock outcrop was first cleared of loose debris such as branches, twigs, leaves, boulders, etc., for a width of about three feet; the covering of wash and contaminated clays was removed by digging a trench, which varied in depth from a few inches to two or more feet depending upon circumstances. The exposed beds were then examined in detail, and such features as the thickness and lithology of each bed were noted. The possible value of each of the beds was noted by observing the presence or absence of foreign bodies (pebbles, concretions, etc.), the texture of the clay especially when moist, and the carbonate content of the clay. The carbonate content was determined by testing with acid, for which purpose a small bottle of dilute hydrochloric acid was always carried. Since calcium carbonate lowers the fusion point of clays, those containing it have limited applications in ceramics, or cannot be used at all if the percentage is too large. Many clays contain carbonates in excessive amounts, hence this test is important.

Having decided which clays were worthy of further attention, a channel sample weighing 20 to 30 pounds was taken from each selected bed or group of beds. Each sample was collected on a square of canvas. The sample was then broken up into small fragments and thoroughly mixed by rolling it back and forth on the canvas. The sample bag, which held about 10 pounds, was then filled. In order to prevent loss of identification of any sample, the sample number was enclosed within the bag as well as being placed on a shipping tag tied to the bag.

CERAMIC CLASSIFICATION OF CLAYS AND THEIR OCCURRENCES IN THE CYPRESS HILLS OF ALBERTA

The physical properties of a clay determines the kind of product that can be made from it. Relatively few clays are suitble for whiteware since they must be white-burning. Clays suitable for stoneware must have a fairly high fusion point. Many clays can be used in making common brick for the burning temperature of this product is comparatively low. Furthermore, the treatment of some clays must follow a certain procedure in order to obtain the best results; for example, in making brick, it must be ascertained first whether the soft-mud, stiff-mud, or dry-press method is best suited to the clay. The following are the principal kinds of clays, the products which can be made from them, and the occurrences of such clays as determined in the present field survey.

KAOLIN: This is a white, residual clay, burning white or nearly so. Kaolin deposits are usually sandy, so that kaolin is usually separated from the sand by washing. This clay is used

in the manufacture of whitewares such as china, semi-porcelain, porcelain, electrical porcelain, floor and wall tile, white Portland cements, and as a filler in paper, paint, cotton goods, and rubber.

Kaolinitic sands occur in the Whitemud formation of both Saskatchewan and Alberta. It was reported that a process, which could recover kaolin economically from the Saskatchewan deposits, had been developed. To the writers knowledge this process has not yet been put into commercial practice. Sands apparently containing a good percentage of kaolin were observed at localities 2, 3, 4, 10, 11, 12, 19, 21, 23, 26, 27, 28, 29, 30, 31, 34; 35; 38 and 39.

BALL CLAYS: These are clays which have good plasticity good working strength, high refractoriness, and are white-burning or nearly so. They are used in the manufacture of whiteware, white earthenware, porcelain, electric porcelain, and floor and wall tile.

They occur in the upper part of the Whitemud formation in south central Saskatchewan where their colours may be white, grey, purple, blue, brown or black. These clays have been used in the pottery industry in Medicine Hat by blending them with others imported from eastern United States. No clays of this type were found in the Cypress hills of Alberta in the course of this survey.

FIRECLAYS: Correct usage would restrict these clays to those that can stand a high temperature without deforming. The fusion-point of such clays should be above 1605°C. Firebrick is the principal product made from these clays and it is used to line furnaces where high temperatures are developed, as in the metallurgical industries. Fireclay is also used in making retorts, locomotive and furnace linings, floor tile, terra cotta, and paving brick.

Fireclays are found in the Whitemud formation in both Saskatchewan and Alberta. They are utilized in Saskatchewan, but Alberta's deposits have not yet been developed. In Alberta, fireclays were found at localities 3, 11, 14, 26, 27, 38, 39 and 41 of which numbers 3, 14, 26, 27, 38 and 39 offer best conditions for development.

STONEWARE CLAYS: These are refractory or semi-refractory clays. They should have good plasticity, good working strength, low shrinkage, and a refractoriness sufficient for the ware to hold its shape during burning. Products made from it are crocks, jugs, bowls and sewer pipe.

Most of the clays which are mined in Saskatchewan belong to this group. Stoneware clays are also abundant in the Whitemud formation in Alberta, and were examined at localities 1, 4, 10, 11, 12, 14, 15, 17, 24, 27, 30, 32, 35, 38, 39 and 41. Of the foregoing localities, the most promising are 1, 4, 10, 11, 12, 17, 32, 35, 39 and 41.

TERRA-COTTA CLAYS: Terra-cotta clays are generally the lower grade, buff-burning semi-fireclays or a blend of fireclays

with low grade clays. Terra-cotta ware includes vases, teapots, and similar ware that are superficially coloured and glazed.

Clays suitable for terra-cotta ware were examined and sampled at localities 3, 10, 11, 13, 14, 26, 27, 38 and 39. Localities especially recommended for detailed examination are numbers 10 and 13.

SEWER-PIPE CLAYS: These clays must mold easily, burn without loss of shape, and take a salt glaze. The burned colour is usually creamy-grey, but red-burning clays can produce just as satisfactory a product. However, in Western Canada consumers are accustomed to the lighter-coloured product, and this colour prejudice would be difficult to overcome should the red-burning sewer pipe be marketed.

Sewer pipe is manufactured on a large scale at Medicine Hat. Clays imported from Saskatchewan are employed. Suitable sewer-pipe clays were observed in the Cypress hills map-area at localities 1, 2, 4, 10, 11, 12, 14, 15, 16 , 17, 24, 26, 27, 28; 30; 31; 32; 33; 35, 38, 39, 40 and 41. Localities deserving of particular attention are 1, 4, 10, 11, 12, 14, 17, 24, 31, 35, 39 and 41.

PAVING-BRICK CLAYS: The clays required for paving brick should be plastic, have good working strength, and should burn at a relatively low temperature. Impure shales are usually employed for this purpose, hence most of the localities examined will have suitable clays. See the localities given under brick clays for detailed information.

BRICK CLAYS: Clays and shales used in making bricks are usually low grade and red burning. The principal requirements for a brick clay are that it mold easily, burn at a relatively low temperature, and that during processing there should be a minimum loss of bricks from cracking or working. These conditions are easily fulfilled, hence brick clays have a wide distribution, and their utilization is largely controlled by the cost of manufacturing and their proximity to market.

Many of the clays examined would make an excellent face brick, but it appears that the relatively high transportation costs and the low price of the product mitigate against their present utilization. Clays of this type worthy of mention were observed at localities 2, 4, 5, 7, 10, 12, 13, 16, 18, 19, 20, 21, 24, 25; 26, 27, 28, 29, 30, 31, 33, 34, 35, 36, 37, 38, 40 and 41. Elsewhere in Alberta good brick clays were examined at localities 43, 44, 46 and 47.

HOLLOW-BRICK CLAYS: Materials used for this product vary as greatly as for brick but the main requisites are that the clay be plastic enough to flow through the die, that it have sufficient strength to retain its shape, and that it burn hard (but not vitrify) at a low temperature (cone numbers .012 to .01 or 840°C to 1110°C.)

Many clays in the map-area are suitable for the manufacture of building tile or could be adapted for it by blending. At the base of most of the stratigraphic sections measured, there occurs a greyish-green plastic shale which has shown up favourably in tests. Localities where these clays were sampled are numbers 1, 2, 5, 10, 16, 19, 20, 22, 35 and 40. Similar clays were also noted at localities 4, 21, 24, 31, 34, 36, 37, 38 and 41. However, at the present time the relatively high cost of transportation and low selling price of the finished product operate against the development of the deposits.

DESCRIPTIONS OF OCCURRENCES

The localities described below were selected in the field either because they were well exposed and hence representative of the clays of that vicinity, or because they contained clays of apparent high quality. It is very probable that an exploration program in which bulldozers and core drills were used would reveal more of the better clays than were found in the present survey. This report does not attempt much more than to indicate the possibilities of the region as a source of clays.

In the following descriptions the sample number follows the description of the bed from which it was taken. If two or more beds are represented in one sample, these beds are specified.

It may be noted that the lithological description as given by the geologist in the descriptions of occurrences differ in many instances from the description of the same clay as given by the ceramic engineer in the table of ceramic tests. Such differences in respect to texture, colour, etc., are not serious, and are to be expected since each has used the classification to which he is accustomed.

The ceramic tests for the clay samples follow immediately after the descriptions of occurrences.

LOCALITY 1

In L.S. 5, Sec. 13, Tp. 8, R. 1, W. 4th Mer., along Graburn creek, about one mile west of the Alberta-Saskatchewan boundary.

	Thickness Feet
Soil, not measured	
Conglomerate, quartzite, pebbles in clay matrix (reworked Cypress hills conglomerate)	4.5
Whitemud Formation	
Clay, purplish, lens of whitish clay 0.2 feet to 0.5 feet thick of sandstone (Sample 1)	4.0
Clay, white, plastic (Sample 2)	2.2
Clay, brown, plastic (Sample 3)	0.5
Base concealed at water level.	
Total thickness	11.2

This rock outcrop contains some of the better clays that were found during the survey. The overburden increases rapidly a short distance from the stream, thereby limiting the quantity of

clay that could be economically recovered. There is a possibility that the whole outcrop has slumped; consequently the development of the deposit should be preceded by the drilling of a few test holes, widely spaced to the southwards, so as to ascertain the continuity of the beds. The beds also outcrop about one-quarter mile downstream, but there they obviously have slumped for some distance. These out-crops are located close to a well travelled road, and hence offer little difficulty in the matter of accessibility.

Results of tests of the above samples are given in Table 1, page 49.

LOCALITY 2

In L.S. 5, Sec. 23, Tp. 8, R. 1, W. 4th Mer., on the north bank of Battle creek, about two miles west of the Alberta-Saskatchewan boundary.

	Thickness Feet
Drift (overburden)	4.0
Whitemud Formation	
Silt, light grey, white weathering, kaolinitic (?) (Sample 4)	6.9
Clay, yellowish-green, plastic (Sample 5)	0.9
Silt, light grey, white weathering (Sample 6)	1.4
Clay, yellowish-green plastic	1.5
Clay, light brown, slightly silty, slightly plastic	2.1
Clay, light yellowish-green silty iron stains	2.0
Sandstone, very fine-grained, base concealed.	
Total thickness	18.8

Sample 7 is a mixture of the three lowest clay beds. They have a total thickness of 5.6 feet.

The overburden is relatively thin, and it should remain so some distance from the outcrop since the latter occurs at the face of a low slope. The exposure is readily accessible and little work would be required to build a truck road to it. It appears that a large amount of clay is readily available here.

Results of the tests of the samples are given in Table 2, page 50.

LOCALITY 3

In L.S. 2, Sec. 26, Tp. 8, R. 1, W. 4th Mer., in Graburn gap, immediately west of the main road.

Whitemud Formation

Clay, white and grey
Clay, white, sandy and silty
Shale, chocolate brown (Sample 8)
Clay, green, plastic.

The thicknesses of the beds were not measured since they were in a confused state, either due to slumping or to thrusting of the continental ice sheet in glacial times. At this locality the chocolate brown shale alone was sampled because it does not occur in outcrop at either of localities 1 or 2. However, it should be

in place under the overburden at those localities and up the slope from the faces of the outcrops. This assumption can probably be verified by the drilling of a few test holes.

Results of the tests of the sample are given in Table 3, page 51 .

LOCALITY 4

In L.S. 5, Sec. 26, Tp. 8, R. 1, W. 4th Mer., about one-half mile west of Graburn gap.

	Thickness Feet
Overburden, to prairie level	33.0
Battle Formation	
Shale, black to brown, slumped, about	12.0
Whitemud Formation	
Shale, light green ,bentonitic (?), gritty, plastic, weathers light yellow (Sample 9)	3.4
Clay, light grey, plastic, white weathering, slightly gritty, probably kaolinitic (Sample 10)	2.0
Silt, light grey, weathers white, grades into sand at bottom (Sample 11)	2.3
Concealed	6.0
Sandstone, fine-grained, micaceous, light brown	1.0
Clay, yellowish-green, slightly silty, plastic	4.0
Sandstone, light brown, fine-grained, slightly clayey, micaceous, probably Eastend formation	1.0
Base concealed.	
Total thickness	64.7

This outcrop is readily accessible by road. The overburden, 45 feet thick, is so excessive as to discourage development at this point. However, further investigations in the vicinity could probably reveal a favourable stripping ratio.

Results of tests of the samples are given in Table 4, page 52.

LOCALITY 5

In L.S. 15, Sec. 30, Tp. 8, R. 1, W. 4th Mer., about four miles west of Graburn gap.

	Thickness Feet
Eastend Formation	
Clay, grey, plastic ,grading into sandstone	6.5
Clay, grey, blocky, slightly silty, plastic, lower six inches very fossiliferous, carbonaceous fragments (Sample 12)	2.0
Shale, green, slightly plastic, gritty, weathers light yellow (Sample 13)	2.0
Sandstone not measured.	
Total thickness	10.5

The above section occurs near the top of the Eastend formation. Some of the clays from this formation are suitable for face brick and tile, but the relatively low selling prices and high transportation costs of these materials would probably prevent utilization of the clays at the present time.

The results of tests on the samples are shown in Table 5, page 53.

LOCALITY 6

In L.S. 7, Sec. 18, Tp. 8, R. 2, W. 4th Mer., in a road cut southeast of Elkwater lake, and near the top of the hill.

Ravenscrag Formation

The Ravenscrag formation occurs in the road cut in several slump blocks near the top of the plateau. The exposures are each twenty feet or more thick, and consist of grey, green and red clays. Sample 14 is a channel sample taken from one of these blocks.

These clays have a doubtful value; but should they prove useful, immense quantities may be obtained where the overburden is light. Open pit methods of winning can be employed.

The results of the test on the clay samples are shown in Table 6, page 54.

LOCALITY 7

In L.S. 1, Sec. 14, Tp. 8, R. 3, W. 4th Mer., along a road cut near the top of the plateau south of Elkwater lake.

	Thickness Feet
Soil	2.0
Ravenscrag Formation	
Clays, pink, maroon, and green, plastic, silty in places (Sample 15)	13.0
Concealed below.	
Total thickness	15.0

These clays resemble those at locality 6, but appear to have a higher grade. They have little overburden, and are favourably situated as regards transportation. It appears that large quantities of clay may be easily obtained here.

The results of the tests of the above samples are given in Table 7, page 54.

LOCALITY 8

In L.S. 2, Sec. 14, Tp. 8, R. 3, W. 4th Mer., in a road cut south of Elkwater lake, and near the top of the Cypress hills.

	Thickness Feet
Soil and gravel	2.0
Ravenscrag Formation	
Shale, greyish-green, somewhat silty	0.9
Shale, as above, more silty, calcareous	2.6
Shale, carbonaceous, black	0.1
Shale, grey, plastic	2.5
Base concealed.	
Total thickness	8.1

Sample 16 was taken of all the beds below the soil and gravel. The clay has too short a firing range for use in ceramics. This is probably due to its high calcium carbonate content. Other clays in the Ravenscrag formation have shown up favourably in tests. (See localities 6 and 7).

Results of the tests of the above sample are given in Table 8, page 55.

LOCALITY 9

In L.S. 2, Sec. 9, Tp. 8, R. 3, W. 4th Mer., near the top of the Cypress hills, and at the base of a prominent north-facing escarpment.

	Thickness Feet
Soil	2.0
Cypress Hills Formation	
Conglomerate, composed of pebbles and cobbles of quartzite and quartzitic sandstone from one-half inch to twelve inches across	46.0
Ravenscrag Formation	
Concealed, clay in part	6.0
Clay, creamy white, calcareous (Sample 17)	1.0
Clay, light grey	1.0
Clay, creamy yellow, gritty	0.2
Clay, pale grey, plastic, base concealed	.5
Total thickness	56.7

Sample 17 is a channel sample of the bottom four beds.

The clays from the Ravenscrag formation were sampled and tested in order to make an official record of it; for the clay, though having a very smooth feel, had indicated a high calcium carbonate content.

Results of the tests on the above sample are given in Table 9, page 55.

LOCALITY 10

In L.S. 16, Sec. 17, Tp. 8, R. 3, W. 4th Mer., about one-half mile east of Fly lake.

	Thickness Feet
Boulder clay and gravel	17.0
Battle Formation	
Shale, dark chocolate brown, bentonitic	6.1
Whitemud Formation	
Clay, light grey, sandy to very sandy (about 50 percent sand) (Sample 18)	3.7
Clay, dark brown (wet) with few rust coloured streaks (Sample 19)	6.2
Clay, plastic, light grey and white mottled (Sample 20)	3.0
Silt, clayey at base, weathers white, kaolinitic (Sample 21)	6.0
Clay, grey and light brownish-green (Sample 22)	6.8
Eastend Formation	
Sandstone, not measured.	
Total thickness	48.8

The Whitemud beds have an aggregate thickness of 25.7 feet, and all appear to be high quality clays. The ratio of overburden to clay (about 1:1) is favourable. It is possible that further prospecting in the vicinity of this outcrop may reveal more favourable

stripping ratios. The outcrop is readily accessible and would require a minimum of road-building to reach it by truck.

Results of the tests on the above clays are given in Table 10, page 56.

LOCALITY 11

In L.S. 5, Sec. 20, Tp. 8, R. 3, W. 4th Mer., about one-half mile north of Fly lake.

	Thickness Feet
Soil and gravel to prairie level	64.0
Boulder clay, in part reworked Battle formation	1.0
Whitemud Formation	
Sandstone and silt, white, kaolinitic, friable	2.6
Sandstone, silty and whitish at bottom, grading into yellowish, brittle, friable sandstone above, micaceous	2.5
Clay, brown to brownish-black, plastic, silty	2.1
Clay, greenish-grey, plastic	0.9
Silt, white weathering, clayey with clay bands (Sample 24)	5.7
Sandstone, yellowish, coarse-grained felspathic, base not dug out	0.5
Total thickness	79.3

Sample 23 is a combination of the 2.1-foot and 0.9-foot beds.

The Whitemud beds appear to be mostly eroded at this place. The remaining clays appear to have a high quality, but the overburden appears to have a prohibitive thickness. It is doubtful if further prospecting in the vicinity would reveal more favourable stripping ratios.

Results of the tests on the above samples are given in Table 11, page 57.

LOCALITY 12

In L.S. 4, Sec. 19, Tp. 8, R. 3, W. 4th Mer., about one mile northwest of Fly lake.

	Thickness Feet
Soil and gravel to prairie level	13.0
Battle Formation	
Shale, dark grey-brown, bentonitic	4.0
Whitemud Formation	
Sand, clayey, white weathering, kaolinitic (Sample 25)	3.2
Clay, sandy, kaolinitic, semi-plastic, white weathering (Sample 25)	3.1
Clay, brownish-green, plastic (Sample 26)	2.5
Clay, dark chocolate brown, slightly silty, rusty brown band near top (Sample 27)	2.8
Clay, pale chocolate brown, plastic, slightly silty (Sample 27)	2.2
Silt, kaolinitic, white (Sample 28)	2.6
Shale, plastic, greenish-white, mottled (Sample 29)	3.0
Shale, brown (Sample 30)	1.0
Clay, green, base concealed.	
Total thickness	37.4

This locality offers one of the best prospects that was discovered in the survey. The clays have a stoneware grade· the

overburden totalling 17 feet, is not excessive, and nowhere in this vicinity will it exceed that thickness by very much. Further prospecting in this vicinity may uncover richer deposits. Transportation difficulties will be at a minimum for the deposit lies close to one of the main roads leading to Medicine Hat.

Results of the tests of the beds sampled are given in Table 12, page 58.

LOCALITY 13

In L.S. 10, Sec. 18, Tp. 8, R. 3, W. 4th Mer., about one mile west of Fly lake.

	Thickness Feet
Battle Formation	
Clay, brown, ranges from medium to dark grey; indurated tuff bands (Sample 31)	37.0
Whitemud Formation	
Clay, white weathering (Sample 32)	6.0
Shale, black, organic	1.0
Clay, white weathering, as above (Sample 33)	6.5
Silt, yellow white	11.0
Base concealed.	
Total thickness	61.5

Sample 34 is a channel sample of the three uppermost Whitemud beds.

Whitemud beds are poorly developed from a ceramic standpoint at this place. The very thick overburden probably eliminates this outcrop as an economic possibility. However the surface slope is to the north here so prospects are good of there being less overburden northwards. A comparison of the above stratigraphic section with that of locality 12 shows strikingly the rapid lateral variation in the Whitemud beds.

Results of the tests of the samples taken at this locality are given in Table 13, page 60.

LOCALITY 14

In L.S. 7, Sec. 9, Tp. 8, R. 4, W. 4th Mer., about two miles northwest of Eagle Butte P.O.

	Thickness Feet
Gravel and soil	2.0
Battle Formation	
Shale, dark brown, tuffaceous band	15.0
Whitemud Formation	
Clay, light grey	0.1
Sandstone, pale grey	1.8
Shale, light grey, plastic (Sample 35)	2.9
Shale, dark brown to black (Sample 36)	4.5
Shale, light grey, smooth, plastic, mottled at top (Sample 37)	7.5
Shale, chocolate brown, plastic (Sample 38)	2.9
Eastend Formation	
Sandstone, fine-grained, silty.	
Total thickness	36.7

This is one of the most favourable localities as a source of stoneware clay. A favourable stripping ratio exists, large quantities should be available, and the outcropping is readily accessible.

Results of tests of the clays sampled are given in Table 14, page 61.

LOCALITY 15

In L.S. 1, Sec. 9, Tp. 8, R. 4, W. 4th Mer., about two miles northwest of Eagle Butte P.O.

	Thickness Feet
Whitemud Formation	
Clay, light grey and darker grey, mottled, white weathering. This outcrop has slumped, so that the true thickness of the bed could not be measured (Sample 39).	

This clay tested satisfactorily, hence a source of stoneware clay may be near. It may be necessary to sink a few test holes to find the beds in place.

Results of the tests of the above sample are given in Table 15, page 62.

LOCALITY 16

In L.S. 1, Sec. 9, Tp. 8, R. 4, W. 4th Mer., about two miles northwest of Eagle Butte P.O.

	Thickness Feet
Soil and gravel	23.0
Battle Formation	
Shale, grey, rusty yellow and black (Sample 40)	12.0
Shale, black, plastic	2.5
Sandstone, yellow	0.3
Shale, chocolate brown with tuff bed	6.5
Whitemud Formation	
Shale, brownish-green, plastic (Sample 41)	3.5
Clay, pale grey, weathers white (Sample 42)	2.5
Shale, light brownish-green	0.7
Clay, medium grey to light grey	2.0
Shale, dark greyish-brown, silty	0.8
Shale, medium grey, rusty spots	0.8
Shale, brownish-green, plastic	0.7
Clay, light greenish-grey, silty, plastic	0.4
Eastend Formation	
Sandstone, brown to buff, silty, micaceous base concealed	10.0
Total thickness	65.7

Sample 43 is a combination of the 0.7-foot and the underlying 2.0-foot beds. Sample 44 is a channel sample of the four lowest Whitemud beds.

The clays belong to face-brick and sewer-pipe types. The Battle formation does not usually furnish clays suitable for use

in ceramics, but it has at this locality since its uppermost bed yields satisfactory tests for face brick.

Results of the tests on the above samples are given in Table 16, page 63.

LOCALITY 17

In L.S. 16, Sec. 4, Tp. 8, R. 4, W. 4th Mer., about one and one-half miles northwest of Eagle Butte P.O.

	Thickness Feet
Whitemud Formation	
Shale, bright green, silty	2.5
Shale, dark greyish-green	2.5
Shale, light grey, white weathering (Sample 45)	1.5
Shale, dark brownish-green, silty	2.0
Shale, dark grey, blocky, base concealed	0.3
Total thickness	8.8

Sample 46 is a channel sample of the four bottom beds. These beds lie under a considerable overburden, consisting in part of Battle shales. Since the clays belong to stoneware grade, and test somewhat favourably, further prospecting in this vicinity is warranted. Such investigations may uncover a favourable stripping ratio.

Results of tests on the above samples are given in Table 17, page 64.

LOCALITY 18

In L.S. 4, Sec. 2, Tp. 8, R. 4, W. 4th Mer., about one mile northwest of Eagle Butte P.O.

	Thickness Feet
Soil and gravel, in part concealed	40.0
Whitemud Formation	
Clay, light grey, with greenish cast (Sample 47)	2.0
Silt, pale grey, slightly clayey (Sample 48)	3.1
Shale, grey, greenish cast, plastic (Sample 49)	2.1
Sandstone, fine-grained, silty, rusty, streaks and inclusions	7.0
Clay, greenish-brown, silty, sandy, base concealed	0.5
Total thickness	54.7

These clays are useful for face brick only, hence have little importance at this time. Moreover, the thickness of the overburden is enough to discourage development.

Results of tests on the above samples are given in Table 18, page 65.

LOCALITY 19

In L.S. 4, Sec. 2, Tp. 8, R. 4, W. 4th Mer., about one mile northwest of Eagle Butte P.O.

	Thickness Feet
Soil and gravel	10.0
Frenchman Formation	
Sandstone, brown, mostly concealed	4.0
Battle Formation	
Shale, dark brown	18.0
Whitemud Formation	
Shale, brownish-green (Sample 50)	2.9
Silt, light grey, kaolinitic (?)	0.3
Shale, light greenish-brown	2.7
Shale, greenish-brown, silty	1.7
Shale, dull brownish-green, slightly silty, plastic	10.0
Eastend Formation	
Silt, light grey brown	2.0
Shale, brownish-green, silty	3.0
Silt, clayey, green	3.2
Shale, green, silty	2.2
Silt, yellowish, purplish ironstone nodules, base concealed	2.0
Total thickness	62.0

Sample 51 is a channel sample of the three lowest Whitemud beds.

The clay beds sampled do not show any exceptional qualities, since they rank no higher than face-brick clays.

Results of the tests on the samples taken are given in Table 19, page 66.

LOCALITY 20

In L.S. 14, Sec. 35, Tp. 7, R. 4, W. 4th Mer., one-half mile northwest of Eagle Butte P.O.

	Thickness Feet
Frenchman Formation	
Sandstone, rusty brown	10.5
Battle Formation	
Shale, dark brown, bentonitic	10.0
Whitemud Formation	
Silt, pale yellowish-grey, clay streaks	0.5
Shale, brownish-green to greenish-grey (Sample 52)	2.5
Silt, as above (Sample 53)	2.5
Shale, green, plastic (Sample 54)	7.2
Base concealed.	
Total thickness	33.2

The shales sampled are below the usual quality of Whitemud clays. They do not appear to have any special importance at this time, and data relating to them are included for record purpose.

Results of the tests on these clays are given in Table 20, page 67.

LOCALITY 21

In L.S. 2, Sec. 2, Tp. 8, R. 4, W. 4th Mer., one-half mile northwest of Eagle Butte P.O.

	Thickness Feet
Soil	1.0
Frenchman Formation	
Sandstone, yellowish-brown, friable, small clayey pellets	37.0
Battle Formation	
Shale, dark brown, bentonitic	2.0
Shale, brown, silty	5.0
Shale, dark brown to black	2.5
Whitemud Formation	
Silt, grey	0.8
Shale, grey, kaolinitic	1.9
Silt, pale grey	2.3
Shale, grey, silty inclusions	3.6
Shale, light brownish-green, silty	3.5
Shale, medium grey-green	0.6
Silt, grey, base concealed	3.0
Total thickness	63.2

Sample 55 includes all beds from top of Whitemud to and including the 3.6-foot bed.

Sample 56 includes all beds from top of Whitemud to and including the 3.5-foot bed.

The Whitemud clays sampled did not prove to be as high quality as usual. It is possible that better clays would be found below the base of the section. However, the exceedingly great thickness of the overburden is enough to discourage further prospecting at this location. Furthermore the position of the outcrop strongly suggests that it is part of a slump block. The strata though have retained their horizontality.

Results of the tests on the samples are given in Table 21, page 68.

LOCALITY 22

In L.S. 2, Sec. 2, Tp. 8, R. 4, W. 4th Mer., about one-half mile northwest of Eagle Butte P.O.

	Thickness Feet
Boulder clay	1.0
Battle Formation	
Shale, dark brownish-grey, bentonitic, average thickness	9.0
Shale, dark brown, silty	1.0
Whitemud Formation	
Shale, light brownish-green	1.1
Sandstone, brownish-grey, clayey	1.9
Shale, brownish-green, plastic, silty at base	4.2
Shale, brownish-green	3.3
Shale, light brownish-green, base concealed	1.0
Total thickness	22.5

Sample 57 is a channel sample of all the Whitemud beds; sample 58 includes all beds below the sandstone.

The quality of the Whitemud clays is not up to the usual standard since they are suitable for structural materials only. The overburden increases rapidly to a maximum of about 20 feet. This outcrop is probably part of a slump block.

Results of the tests on the samples are given in Table 22, page 69.

LOCALITY 23

In L.S. 1, Sec. 7, Tp. 8, R. 3, W. 4th Mer., one and one-half miles south of Fly lake.

	Thickness Feet
Frenchman Formation	
Sandstone, buff, with dirty brown, carbonaceous, clay-like shale	5.0
Whitemud Formation	
Silt, white kaolinitic (Sample 59)	4.5
Silt, yellow	1.0
Clay, white to buff weathering kaolinitic	2.5
Clay, light grey, weathering, kaolinitic	2.0
Clay, brown	4.5
Shale, black, organic	2.0
Eastend Formation	
Concealed	6.0
Silt, buff and grey-green, argillaceous	39.0
Total thickness	66.5

Sample 60 is a channel sample of the four topmost Whitemud beds.

It appears that all the Battle formation and the upper part of the Whitemud formation have been eroded at this location. The clays sampled could possibly be made more plastic by blending with lower beds.

Results of the tests on the clay samples are given in Table 23, page 69.

LOCALITY 24

In L.S. 2, Sec. 6, Tp. 8, R. 3, W. 4th Mer., high up on the east side of Medicine Lodge coulee.

Overburden increases from zero to 60 feet.	Thickness Feet
Frenchman Formation	
Sandstone, fine-grained, yellowish-brown	1.5
Battle Formation	
Shale, dark grey, bentonitic, gypsiferous	5.0
Whitemud Formation	
Clay, grey, silty streaks (Sample 61)	3.7
Clay, brownish-green, limonitic (Sample 62)	1.8
Silt, white weathering (Sample 63)	10.4
Clay, dark brown to black, highly refractory (Sample 64)	1.0
Silt, white weathering, clay streaks (Sample 65)	4.0
Clay, pale grey, plastic, white weathering (Sample 66)	2.9
Clay, greenish-brown, plastic, silty, base concealed	1.0
Total thickness	31.3

The above stratigraphic section contains some very interesting clays. One of these is the dark brown and black, highly refractory clay bed. This bed could be traced northwards for several hundred feet, and throughout that distance retains a fairly uniform thickness. Another bed of good quality clay is that underlying the refractory clay bed. This clay is suitable for stoneware.

The exposure detailed above is close to a good road. A road to the shale deposits could be built quite inexpensively. The deposit is 30 miles from Medicine Hat in a straight line.

Results of tests of the above samples are given in Table 24, page 70.

LOCALITY 25

In L.S. 2, Sec. 6, Tp. 8, R. 3, W. 4th Mer., high on the east side of Medicine Lodge coulee.

	Thickness Feet
Battle Formation	
Shale, dark grey	4.0
Whitemud Formation	
Shale, brownish-green, silty clay in upper 2 feet	4.8
Shale, brownish-green, plastic	4.0
Shale, brown, silty, base concealed	3.0
Total thickness	15.8

Sample 67 was taken from the two uppermost Whitemud beds.

The shales exposed are the face brick type. It is possible that a thick section of clays of this type is present here, but it is mostly covered. The overburden is not excessive, and the shales should be economically won. However, the distance from processing plants mitigates against their development.

Results of the tests on the clay sample are given in Table 25, page 72.

LOCALITY 26

In L.S. 15, Sec. 31, Tp. 7, R. 3, W. 4th Mer., high on the east side of Medicine Lodge coulee.

	Thickness Feet
Frenchman Formation	
Sandstone, yellowish-brown, friable	25.0
Battle Formation	
Shale, brown, clayey, plastic	2.2
Whitemud Formation	
Shale, pale grey, dries whitish	4.5
Shale, dark grey	4.5
Shale, light grey (Sample 68)	1.0
Shale, dark grey, with jet black streak, highly refractory (Sample 69)	1.0
Clay, gritty, kaolinitic (?)	3.0
Shale, bentonitic, pale green	5.2
Shale, cream coloured, kaolinitic	1.1
Shale, greenish-grey	1.0
Sandstone, whitish, kaolinitic (?)	3.7
Shale, grey-green, clayey	0.5
Total thickness	52.7

The Whitemud beds show up prominently on both sides of Medicine Lodge coulee. Apparently highly kaolinitic sands are present here, and offer possibilities for the recovery of kaolin. Along most of the east side of the coulee the overburden is so thick as to make recovery of the clay economically prohibitive. It should be possible to trace these beds to localities where the stripping ratio is favourable. Road building to operational sites would present no difficulty.

Results of the tests on the clay samples are given in Table 26, page 73.

LOCALITY 27

In L.S. 16, Sec. 31, Tp. 7, R. 3, W. 4th Mer., high on the east side of Medicine Lodge coulee.

	Thickness Feet
Soil and drift	33.0
Battle Formation	
Shale, dark grey-brown, bentonitic	3.0
Whitemud Formation	
Clay, grey, plastic, yellowish staining in places	1.4
Shale, silty, kaolinitic (?) (Sample 70)	4.6
Shale, brownish-green plastic	1.8
Shale, light grey, plastic	1.8
Shale, brownish-green	2.7
Sandstone, grey, kaolinitic (?)	0.9
Shale, brownish, plastic	0.4
Eastend Formation	
Sandstone, light brownish-grey	11.0
Shale, medium grey	2.0
Total thickness	62.6

Sample 71 is a channel sample of the whole Whitemud section.

Some of the best clays occur on the sides of Medicine Lodge coulee. Similar or better clays may be abundant elsewhere but are concealed by the covering of brush. Though there is a thick overburden in this section, it becomes less to the south and north.

Results of the tests on the above clay samples are given in Table 27, page 74.

LOCALITY 28

In L.S. 16, Sec. 31, Tp. 7, R. 3, W. 4th Mer., high on the east side of Medicine Lodge coulee.

	Thickness Feet
Soil	2.0
Frenchman Formation	
Sandstone, yellowish-brown	28.0
Battle Formation	
Shale, dark brown	0.9

Whitemud Formation	Thickness Feet
Clay, grey, dries white	2.0
Silt, white, kaolinitic, fine, sandy	1.5
Clay, light grey, dries white	3.0
Clay, greenish-brown	1.4
Clay, light grey, mottled	1.1
Clay, greenish-brown, base concealed	0.2
Total thickness	40.1

Sample 72 is a channel sample of all Whitemud beds excepting the bottom one.

The clays in this exposure are somewhat lower in quality than most Whitemud clays sampled. It may be that some of the individual beds, or smaller groups of beds, are worthy of further attention.

Results of the tests of the above clay sample are given in Table 28, page 75.

LOCALITY 29

In L.S. 8, Sec. 31, Tp. 7, R. 3, W. 4th Mer., on th east side of Medicine Lodge coulee.

	Thickness Feet
Soil not measured.	
Whitemud Formation	
Shale, dull green	1.0
Silt, gritty, dries white	1.0
Shale, greenish-grey, dries white	2.0
Shale, dull green, bentonitic	1.5
Silt, gritty, dries white, kaolinitic (?)	0.8
Shale, dull green, bentonitic	0.7
Silt, dries white, gritty, bentonitic (Sample 73)	1.0
Shale, dull green, bentonitic	1.2
Silt, weathers white, gritty feel, kaolinitic	2.0
Eastend Formation	
Sandstone, fine-grained, silty, bright yellow at top	6.6
Shale, dull green, bentonitic (Sample 75)	2.5
Sandstone, fine-grained, silty	3.6
Shale, grey	1.0
Shale, brown, abundant plant fragments	2.5
Total thickness	27.4

Sample 74 is a channel sample of all Whitemud beds in the above section.

Sample 76 is a channel sample of the three Eastend beds below the uppermost stratum.

The clays in this section are well exposed and are very conspicuous. They do not have exceptional qualities however.

Results of tests on these samples are given in Table 29, page 76.

LOCALITY 30

In L.S. 11, Sec. 32, Tp. 7, R. 3, W. 4th Mer., on the east side of Medicine Lodge coulee.

	Thickness Feet
Overburden, soil, drift, etc.	40.0
Battle Formation	
Shale, dark grey to brownish with tuff bands	22.0
Whitemud Formation	
Clay, pale grey, plastic, silty in places	1.8
Silt, pale grey, kaolinitic, slightly clayey	2.2
Clay, brownish-green, slightly silty, plastic	5.5
Base concealed.	
Total thickness	71.5

Sample 77 is a channel sample of Whitemud beds in above section.

The overburden in this section totals 62 feet, which thickness probably would prohibit development even if the clays had a higher quality. Individual beds though may warrant testing and tracing to more favourable quarrying sites.

Results of the tests on the above clays are given in Table 30, page 77.

LOCALITY 31

In L.S. 2, Sec. 32, Tp. 7, R. 3, W. 4th Mer., on the east side of Medicine Lodge coulee.

	Thickness Feet
Frenchman Formation	
Sandstone, yellowish-brown	1.0
Battle Formation	
Concealed	5.5
Shale, dark grey	2.0
Whitemud Formation	
Silt, pale grey, white weathering, grading into sandstone below	4.5
Sandstone, grey, party concealed	5.0
Shale, green, silty	1.3
Silt, whitish, kaolinitic (Sample 78)	1.5
Shale, green, plastic	0.5
Concealed	2.2
Shale, brownish-green, slightly silty	1.0
Silt, pale grey, base concealed	0.5
Total thickness	25.0

These clays do not appear to possess a high quality. They are suitable principally for structural products.

Results of the tests on the above clay sample are given in Table 31, page 77.

LOCALITY 32

In L.S. 12, Sec. 25, Tp. 7, R. 4, W. 4th Mer., one mile south of Eagle Butte P.O.

	Thickness Feet
Whitemud Formation	
Clay, pale grey, white weathering, slumped thickness about (Sample 79)	4.1

This outcrop is obviously a slump block, so it was not measured. The most promising clay stratum, that above, alone was sampled. The clay is a stoneware type so that prospecting to find the bed in place is quite warranted.

Results of tests on the above clay sample are given in Table 32, page 78.

LOCALITY 33

In L.S. 6, Sec. 25, Tp. 7, R. 4, W. 4th Mer., about one mile south of Eagle Butte P.O.

	Thickness Feet
Soil, not measured.	
Battle Formation	
Shale, dark brown	4.0
Bentonite, impure	0.3
Shale, dark greyish-brown, bentonitic	2.2
Sandstone, with numerous clay particles	.03
Shale, brownish-green ,silty	1.5
Shale, greyish-brown	12.0
Whitemud Formation	
Clay, pale grey to greenish, yellow stains (Sample 80)	3.4
Shale, dark brown to black, brittle, silty (Sample 81)	2.9
Clay, brownish-green, plastic	0.3
Clay, pale grey, silty, base concealed	3.0
Total thickness	29.9

The Whitemud clays sampled here are of low quality. It is possible that higher grade clays could be found by opening more of the section by stripping.

Results of the tests on the clay samples are given in Table 33, page 78.

LOCALITY 34

In L.S. 16, Sec. 24, Tp 7, R. 4, W. 4th Mer., one and one-half miles southeast of Eagle Butte P.O.

	Thickness Feet
Soil and gravel to prairie level	7.5
Whitemud Formation	
Clay, light grey, plastic, white weathering (Sample 82)	2.1
Clay, brownish-green, plastic (Sample 83)	2.1
Silt, pale grey, sandy, kaolinitic	2.6
Sandstone, yellowish to rusty brown, fine-grained, argillaceous	1.0
Clay, greyish-brown, plastic	0.4
Silt, pale grey, white weathering, kaolinitic (?)	0.3
Clay, greyish-green, plastic	0.3
Clay, pale grey, silty, kaolinitic (?), white weathering, base concealed	0.2
Total thickness	16.5

Only the upper part of the Whitemud formation is exposed here. Further trenching might reveal more valuable clays. Though these clays have a relatively light overburden, their distance from processing plants in Medicine Hat makes their utilization doubtful.

Results of the tests on the above samples are given in Table 34, page 79.

LOCALITY 35

In L.S. 1, Sec. 25, Tp. 7, R. 4, W. 4th Mer., about one and one-half miles southeast of Eagle Butte P.O.

	Thickness Feet
Soil and gravel to prairie level	14.2
Battle Formation	
Clay, dark greyish-brown	2.3
Whitemud Formation	
Clay, medium grey, (Sample 84)	1.9
Clay, pale grey, white weathering, limonitic spots (Sample 85)	2.1
Clay, silty, kaolinitic, light grey (Sample 86)	2.3
Clay, light grey, greenish cast, plastic (Sample 87)	0.2
Clay, brownish-green, plastic (Sample 87)	1.0
Shale, light greyish-green, silty, kaolinitic (Sample 88) (?)	5.7
Shale, medium to dark grey, slightly silty (Sample 89)	4.1
Clay, brownish-green, silty (Sample 90)	2.9
Sandstone, pale grey, kaolinitic, slightly clayey (Sample 91)	1.2
Shale, brownish-green, slightly silty, plastic, base concealed (Sample 92)	5.1
Total thickness	43.0

This is one of the most promising clay deposits uncovered during the survey, and certainly the most favourable in most respects in Medicine Lodge coulee. The clays are a good grade, being suitable for stoneware. The overburden is not too thick, being 16.5 feet at this place, and should become thinner to the southwest away from the face of the exposure. Access to the outcropping is easy, it being possible to drive to it by automobile. The deposit is about 35 miles by truck from Medicine Hat. A very large quantity of clay should be available here.

Results of the tests on the above clays are given in Table 35, page 80.

LOCALITY 36

In L.S. 8, Sec. 34, Tp. 7, R. 3, W. 4th Mer., on the east side of Medicine Lodge coulee.

	Thickness Feet
Overburden soil and wash	6.0
Ravenscrag Formation	
Clay, light buff and grey, base concealed (Sample 93)	2.0
Total thickness	8.0

This clay was sampled in order to complete the records. It appears to be too low grade to warrant further consideration in ceramics.

Results of the tests on the sample are given in Table 36, page 82.

LOCALITY 37

In L.S. 8, Sec. 34, Tp. 7, R. 3, W. 4th Mer., on the east side of Medicine Lodge coulee.

	Thickness Feet
Soil and gravel, not measured.	
Clay, silty, reworked	2.6
Ravenscrag Formation	
Silt, white-weathering (Sample 94)	1.5
Clay, greenish, silty	1.0
Silt, base concealed	1.0
Total thickness	6.1

The remarks with respect to Sample 93 are also applicable here.

Results of the test on the clay sample are given in Table 37, page 83.

LOCALITY 38

In L.S. 11, Sec. 18, Tp. 7, R. 2, W. 4th Mer., on Thelma creek, two miles south of Thelma P.O.

	Thickness Feet
Soil and gravel to prairie level	18.0
Battle Formation	
Clay, dark brown	2.0
Whitemud Formation	
Clay, pale grey (Sample 95)	1.2
Clay, pale grey, plastic, silty in places (Sample 96)	4.0
Clay, brownish-green and pale grey intercalated (Sample 97)	3.9
Shale, dark brown to black (Sample 98)	2.5
Clay, light greenish-grey, plastic (Sample 99)	2.5
Silt and clay, pale grey, kaolinitic (?) white weathering silt with thin bands of brownish-green clay (Sample 100), base concealed	3.0
Total thickness	37.1

This locality has the best clays and the best conditions for recovering them of any outcrops examined. The clays are stoneware type, the stripping ratio is good (one to one), and the outcrop is accessible by automobile. The overburden should have a fairly constant depth, since the terrain here is flat. The locality is about 40 miles by road from Medicine Hat.

Results of the tests of the samples taken are given in Table 38, page 84.

LOCALITY 39

In L.S. 6, Sec. 18, Tp. 7, R. 2, W. 4th Mer., on Thelma creek, about two miles south of Thelma P.O.

	Thickness Feet
Soil and gravel to prairie level	10.0
Battle Formation	
Clay, dark greyish-brown	2.0
Concealed	2.0
Whitemud Formation	
Shale, pale grey, greenish cast (Sample 101)	1.5
Concealed	3.0
Clay, silty, light grey	1.0
Shale, chocolate brown (Sample 102	1.7
Shale, dark brown and black (Sample 103)	0.8
Clay, pale grey, plastic	0.4
Silt, white ,clayey, kaolinitic, base concealed	0.5
Total thickness	22.9

This locality is about one-quarter mile from locality 39, and the clays at both places are similar. Hence the remarks with respect to the preceding locality are also applicable here.

Results of the tests on the above clay samples are given in Table 39, page 86.

LOCALITY 40

In L.S. 8, Sec. 5, Tp. 7, R. 1, W. 4th Mer., two and one-half miles south of Fox P.O.

	Thickness Feet
Glacial drift, wash and boulders	3.0
Whitemud Formation (Reworked?)	
Silt, grey, white weathering (Sample 104)	3.5
Clay, greyish-brown, grading to yellowish-green, plastic, gritty (Sample 105)	2.7
Sand, light brown, very fine-grained	0.4
Silt, grey, argillaceous (Sample 106)	2.0
Clay, green, plastic	0.8
Concealed	4.0
Silt, greyish-green, yellowish iron-stained streaks (Sample 107)	5.3
Clay, green, slightly silty, but becoming less so below (Sample 108)	2.0
Base of section (bottom of auger hole).	
Total thickness	23.7

Locality 40 is located about two and one-half miles south of Fox P.O., and about 1,000 feet west of the trail that leads to that place. The terrain here is treeless, and slopes gently southwards. Attention was drawn to the possibilities in this sector of the hills by the light coloured clays that had been thrown out by burrowing animals.

The above section is a composite, which was obtained by digging pits and sinking auger holes on the hillside. The clays and silts encountered in these two holes appear to be reworked Whitemud beds, but are remarkably pure if they have been subject to redeposition. Though the clays are suitable for brick and possibly stoneware, better grade clays may be in place further up the slope.

Results of the tests on the above clay samples are given in Table 40, page 87.

LOCALITY 41

In L.S. 8, Sec. 5, Tp. 7, R. 1, W. 4th Mer., about two and one-half miles south of Fox P.O.

	Thickness Feet
Glacial drift, wash and boulders	3.5
Whitemud Formation (Reworked?)	
Silt, greyish-green, whitish weathering (Sample 109)	1.2
Clay, green and greenish-brown, silty streaks, variable plasticity (Sample 110)	4.5
Clay, green, mottled, plastic, grading into silty clay (Sample 111)	1.6
Silt, as above (Sample 112)	1.0
Bottom of auger hole.	
Total thickness	11.8

This section was dug out a few hundred feet up the slope from locality 40 in order to ascertain if clay beds in place would be encountered, since it was thought that the beds at locality 40 appeared to be reworked. However, the beds at locality 41 are so similar to those at the other locality as to suggest that all beds are reworked. The source of these beds, if they are reworked, could be the Whitemud formation which, in that case, should be farther up the hillside. A series of shallow test holes spaced a few hundred feet apart would yield sufficient information to solve this question.

Results of the tests on the above clay samples are given in Table 41, page 89.

CERAMIC TESTS

EXPLANATION OF TERMS

TEMPERING WATER OR WATER OF PLASTICITY: The percentage by weight of water added to the dry clay to develop its best working properties.

WORKING PROPERTIES: These include the ease with which the wet clay can be shaped and the ability of the clay to hold that shape.

PYROMETRIC CONE EQUIVALENT (P.C.E.): A sample of the clay is made up to a certain standard tetrahedral shape and size. It is then heated in increasing temperatures and in an oxidizing atmosphere until the pyramid is so soft that it bends to touch the base on which it stands. The temperature at which it bends is its P.C.E., and it is always expressed as a cone number, for each range of temperature is represented by a cone number. Cone numbers range form .022 to 42. The equivalent temperature ranges are from 585°C. (1085°F.) to 2015°C. (3660°F.).

APPROXIMATE TEMPERATURE: The temperature of the P.C.E. of the clay, that is, the temperature at which it softened sufficiently to lose its shape.

DRYING BEHAVIOUR: The extent to which clays crack upon drying.

DRYING SHRINKAGE: The decrease in the length of the dried specimen compared to its length when wet. It is expressed as a percentage.

FIRE SHRINKAGE: The difference in the percentages between the drying shrinkage and the shrinkage after firing, based on the wet length. The total shrinkage from the wet state is the sum of the drying and firing shrinkages.

CONE: The temperature at which the bricklets were burned. Temperatures used in firing the clay specimens described in this report range from cone .08 to 10. Equivalent temperatures for these cones are listed below.

Cone	°F.	°C.
.08	1733	945
.06	1841	1005
.04	1922	1050
.03	1976	1089
.02	2003	1095
.01	2030	1110
1	2057	1125
5	2156	1180
6	2174	1190
10	2300	1260

ABSORPTION: The percentage by volume of pore space in the fired product. It is found by soaking the product in water and measuring the quantity of liquid absorbed.

TABLES OF RESULTS

TABLE 1

Locality 1.....L.S. 5, Sec. 13, Tp. 8, R. 1,W.4th—Along Graburn creek close to the eastern Alberta boundary

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
1	Non-calcareous, black and white clay	26.5	Very plastic, tough, works well	19	2759	Cracked badly in rapid drying	8.8	04	1.5	11.6	Creamy buff	Fairly hard	Suitable for common brick and possibly for stoneware if colour is not important
								02	2.9	8.8	Buff	Hard	
								1	3.9	6.4	Buff	Very hard	
2	Non-calcareous, grey clay	25.3	Very plastic, tendency to stick, works fairly well	19	2759	Cracks badly in rapid drying	7.4	04	1.2	12.1	Creamy buff	Fairly hard	Suitable for common brick and possibly for stoneware, might take a salt glaze
								02	3.3	7.9	Light buff	Hard	
								1	4.0	5.4	Buff	Very hard	
3	Non-calcareous, grey clay	31.3	Very plastic, sticky	18	2705	Cracks badly in both rapid and slow drying	10.5	04	2.8	7.9	Buff	Very hard	Value is doubtful since it cracks badly
								02	4.0	3.9	Buff	Steel hard	
								1	5.7	1.8	Brown	Steel hard, poor colour	

TABLE 2

Locality 2.....L.S. 5, Sec. 23, Tp. 8, R. 1, W.4th—Along Battle creek near the eastern Alberta boundary

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
4	Cream coloured, calcareaus clay	26.0	Fairly plastic, works well, silty	15	2570	Safe in rapid drying	7.2	1	0.0	14.7	Light buff	Soft	Clean burning, silty; could be improved by blending with underlying deposits
								6	1.7	9.3	Light buff	Fairly hard	
								10	6.0	1.1	Light grey	Steel hard, vitirified	
5	Buff coloured, bentonitic clay	23.7	Very plastic, tough, works fairly well	10	2300	Cracks in slow drying	8.4	06	0.3	10.7	Light salmon	Fairly hard	Suitable for pressed brick and quarry tile
								03	4.8	2.2	Light red	Very hard	
								1	4.7	0.2	Dark red	Steel hard	
6	Creamed coloured clay	26.2	Good plasticity, works well	14	2535	Cracked in rapid drying	9.2	03	2.0	8.4	Buff	Fairly hard	Could make an attractive face brick; will possibly take a salt glaze
								1	4.0	3.9	Darker buff	Very hard	
7	Cream coloured bentonitic clay	28.2	Very plastic, sticky, works fairly well, gritty	11	2340	Cracked very badly in rapid drying	10.3	06	0.3	11.5	Light salmon	Fairly hard	Suitable for face brick and tile
								03	4.5	3.1	Light red	Very hard	
								1	5.7	0.4	Brownish red	Steel hard	

TABLE 3

Locality 3.....L.S. 2, Sec. 26, Tp. 8, R. 1, W.4th—Graburn gap, near the eastern Alberta boundary

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
8	Brown clay	31.5	Very plastic, tough, works well	26.5	2910	Cracked very badly in rapid drying	11.0	06	2.3	13.7	Buff	Hard	Semi-fireclay
								6	7.7	2.8	Salmon buff	Steel hard	
								10	8.3	1.1	Grey brown	Steel hard	

TABLE 4

Locality 4.....L.S. 5, Sec. 26, Tp. 8, R. 1, W.4th—Grabu n gap

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
9	Buff coloured, bentonitic clay	32.8	Very plastic, sticky	11	2340	Cracked badly in slow drying	11.6	06	1.0	11.1	Salmon	Fairly hard, badly cracked	Possible use for brick and tile if blended with the underlying deposits
								03	4.0	5.1	Red	Hard, badly cracked	
								1	5.3	2.4	Brownish red	Steel hard, badly cracked	
10	Cream coloured clay	28.0	Good plasticity, works well	14	2535	Cracked in rapid drying	9.1	03	4.3	7.0	Buff	Hard	Stoneware type clay; could be improved by blending with sample No. 11
								1	6.0	1.4	Dark buff	Steel hard	
								6	7.3	0.8	Brown buff	Steel hard	
11	Cream coloured, silty clay	15.0	Low plasticity, gritty, works fairly well	15	2570	Safe in rapid drying	5.8	1	-0.7*	15.2	Light buff	Soft	Clean burning, silty; should be useful if blended with No. 10
								6	2.4	10.7	Light buff	Fairly hard	
								10	7.5	1.5	Light grey	Steel hard	
									*Expansion				

TABLE 5

Locality 5.....L.S. 15, Sec. 30, Tp. 8, R. 1, W.4th—4 miles west of Graburn gap

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
12	Very calcareous, light grey clay	30.9	Good plasticity, works well	3	2090	Safe in rapid drying	8.2	03	3.3	15.8	Light salmon	Fairly hard	Very short firing range; not suitable for ceramic products
								1	10.0	0.1	Brownish buff	Vitrified over-fired	
13	Buff coloured, bentonitic clay	29.0	Highly plastic, sticky, works fairly well	9	2280	Cracked badly in rapid drying	10.2	03	2.7	7.0	Good red	Hard	Suitable for face brick if dried slowly
								1	6.3	2.1	Dark red	Steel hard	
								6	6.3	1.9	Dark red	Steel hard	

TABLE 6

Locality 6.....L.S. 7, Sec. 18, Tp. 8, R. 2, W. 4th—in road cut southeast of Elkwater lake

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
14	Non-calcareous, light grey clay	31.5	Good plasticity, works well	14.5	2552	Cracks badly in both rapid and slow drying	9.2	04	3.3	10.8	Salmon	Hard	Value is doubtful since it cracks badly in drying
								02	5.7	5.6	Salmon	Very hard	
								1	7.3	1.3	Fair red	Steel hard	

TABLE 7

Locality 7.....L.S. 1, Sec. 14, Tp. 8, R. 3, W.4th—Along hill road south of Elkwater lake

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
15	Slightly bentonitic, pinkish buff clay	26	Very plastic, works well	14	2535	Cracks badly in rapid drying	11.0	06	1.0	10.4	Dark salmon	Hard	Possible use for face brick and quarry tile by dry press method
								03	4.0	4.5	Light red	Steel hard	
								1	5.4	0.9	Brownish red	Steel hard, nearly vitrified	

TABLE 8

Locality 8.....L.S. 2, Sec. 14, Tp. 8, R. 3, W.4th—Along hill road south of Elkwater lake

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
16	Very calcareous, cream coloured clay	24.2	Good plasticity, works well	3.5	1930	Cracks badly in rapid drying	8.7	1	2.0	2.5	Light buff	Fairly hard, warped in firing	Firing range too short for use in making ceramic products

TABLE 9

Locality 9.....L.S. 2, Sec. 9, Tp. 8, R. 3, W.4th—Below the rim of the Bench

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
17	Very calcareous, buff coloured clay	22.8	Slightly tough, works well	2	2070	Cracks very badly in rapid drying	9.3	03	0.6	11.7	Light salmon	Hard	Firing range too short for use in ceramic products
								1	....	7.0	Salmon buff	Very hard, warped in firing	

TABLE 10

Locality 10.....L.S. 16, Sec. 17, Tp. 8, R. 3, W.4th—One-half mile east of Fly lake

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
18	Light grey, sandy clay	17	Gritty, fairly plastic, works fairly well	20	2770	Slight cracking in rapid drying	9.0	1	-3.6*	9.9	Cream	Fairly soft	Siliceous semi-fire-clay; suitable for blending with underlying deposits
								6	-3.3*	9.5	Dark cream	Fairly hard	
								10	-2.0*	5.8	Buff	Hard, black specks	
19	Tan coloured, slighty gritty clay	23	Highly plastic, tough	19	2760	Cracked badly in rapid drying	8.7	06	0.7	11.8	Salmon	Hard	Suitable for structural products; off-colour for stoneware products
								03	3.2	6.4	Salmon pink	Very hard	
								6	4.7	3.0	Light red	Steel hard	
								10	5.4	1.9	Brown	Steel hard	
20	Light grey clay	23	Good plasticity, works well	17	2665	Safe in rapid drying	6.2	03	3.5	7.9	Cream	Hard	Suitable for high grade stoneware, terra cotta, artware,etc.
								6	5.6	2.9	Dark cream	Very hard	
								10	6.0	0.0	Grey	Vitrified	
									*Expansion				

TABLE 10 (Continued)

Locality 10.....L.S. 16, Sec. 17, Tp. 8, R. 3, W.4th—One-half mile east of Fly lake

21	Light grey clay	22	Good plasticity, works well	16	2645	Cracked badly in rapid drying	6.1	1	2.1	9.2	Dark cream	Fairly hard	Possible use for stoneware if blended to prevent cracking in drying
								6	3.8	6.8	Dark cream	Hard	
								10	6.4	0.3	Light grey	Vitrified	
22	Cream coloured clay	23	Good plasticity, works well	15	2570	Cracks badly in rapid drying	7.8	06	0.3	11.4	Light salmon	Fairly hard	Possible use for face brick, sewer pipe and flue lining
								03	3.2	5.5	Salmon buff	Very hard	
								6	6.3	0.1	Brown	Steel hard	

TABLE 11

Locality 11..... L.S. 5, Sec. 20, Tp. 8, R. 3, W. 4th—One-half mile north of Fly lake

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
23	Greyish brown, plastic clay	28.0	Very plastic, works well	28	2940	Cracked badly in rapid drying	8.7	03	3.0	11.5	Cream	Hard	Semi-fireclay
								6	6.3	4.6	Light buff	Very hard	
								10	7.3	1.8	Brown	Steel hard	
24	Nearly white, silty clay	20.5	Fairly plastic, weak, works fairly well, silty	19	2760	Safe in rapid drying	6.4	1	0.2	11.8	White	Fairly soft	Sandy, white-burning stoneware type clay; could be improved by blending with a more plastic clay to improve workability and reduce absorption
								6	1.8	8.0	White	Hard	
								10	4.5	2.8	Very light grey	Steel hard	

TABLE 12

Locality 12.....L.S. 4, Sec. 19, Tp. 8, R. 3, W.4th—One mile northwest of Fly lake

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage age	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
25	Light grey, sandy clay	23.8	Good plasticity, works fairly well, sandy	19	2760	Cracked badly in rapid drying	8.2	1	-0.4*	10.6	Light buff	Soft	Sandy, clean burning clay; could possibly be used if blended
								6	0.8	8.5	Light buff	Fairly soft	
								10	2.5	4.8	Dark buff	Hard	
								06	1.0	10.5	Salmon	Fairly hard	
26	Light buff, bentonitic clay	30.0	Highly plastic, tendency to be sticky, works well	13	2460	Cracked very badly in rapid drying	11.1	03	4.0	4.2	Dark salmon	Very hard	Possible use for structural products
								1	6.0	0.6	Brownish red	Steel hard	
27	Brown clay	32.5	Highly plastic, slightly tough, works well	18.5	2730	Cracked badly in rapid drying	11.8	06	2.0	13.8	Salmon	Hard	Possible use for structural products
								03	4.8	4.4	Dark salmon	Very hard	
								1	6.7	1.7	Light brownish red	Steel hard	

TABLE 12 (Continued)

Locality 12.....L.S. 4, Sec. 19, Tp. 8, R. 3, W.4th—One mile northwest of Fly lake

28	Light cream coloured, silty clay	24.1	Rather short, flabby, works fairly well	16	2640	Safe in rapid drying	6.0	1	0.0	14.4	Cream	Soft	Stoneware clay
								6	4.8	4.9	Darker cream	Hard	
								10	7.2	0.1	Light grey	Vitrified	
29	Pale grey clay	29.4	Very plastic, works fairly well	12	2390	Cracked badly in rapid drying	8.1	06	2.0	11.7	Light salmon	Fairly hard	Tender drying stoneware type clay; requires blending with some non-plastic material
								03	6.8	0.4	Dark buff	Very hard	
								1	7.0	0.0	Dark brown	Vitrified	
30	Dark brown clay	31.2	Highly plastic, works well, somewhat tough	16	2640	Cracks very badly in rapid drying	10.7	06	1.7	10.3	Light salmon	Hard	Suitable for structural products
								03	3.5	6.0	Salmon	Very hard	
								1	4.7	2.9	Light brownish red	Steel hard	
									*Expansion				

TABLE 13

Locality 13.....L.S. 10, Sec. 18, Tp. 8, R. 3, W.4th—One mile west of Fly lake

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
31	Dark brown, bentonitic shale		Quite sticky if too much water is added			Cracked badly in drying	10.4	010	.....		Salmon buff		Cracks too badly to be of interest in ceramics
								02	6.3		Deep yellow buff		
								5	6.3		Light red		
32	Fine-grained, light grey shale		Good plasticity			Safe and normal	6.3	010	.....		Light cream		Suitable for face brick, terra cotta, and similar ware
								02	2.0		Buff		
								6	6.3		Terra cotta shade		
33	Fine-grained, siliceous, light grey shale		Good plasticity			Safe	6.3	010	.....				Best possible use is for blending with the above beds
								02	4.1		Cherry red		
								6	4.2		Brown over-fired		
34	Light grey shale, mixture of Nos. 32 and 33		Good plasticity, but slightly sticky			Safe and normal	6.4	010	.....		.....		Suitable for face brick, terra cotta, and possibly sewer pipe
								02	2.0		Medium terra cotta		
								6	6.3		Brownish red		

TABLE 14

Locality 14.....L.S. 7, Sec. 9, Tp. 8, R. 4, W. 4th—Two miles northwest of Eagle Butte P.O.

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
35	Cream coloured clay	27.5	Good plasticity, works well	14	2535	Cracked badly in rapid drying	8.8	03	4.0	5.6	Buff	Very hard	Tender drying, stoneware type clay
								1	6.0	0.7	Dark buff	Steel hard	
								6	6.5	0.7	Dark buff	Steel hard	
36	Brown clay	31.8	Very plastic, works well	18.5	2730	Cracked in air drying	11.4	06	2.7	12.2	Buff	Hard	Suitable for structural products
								03	5.1	6.0	Buff	Very hard	
								1	5.3	4.1	Dark salmon	Very hard	
37	Dark grey clay	26.0	Good plasticity, works well	15	2570	Cracked in rapid drying	7.8	06	1.7	12.2	Dark cream	Fairly hard	Tender drying, stoneware type clay
								03	4.0	6.2	Buff	Hard	
								1	6.3	0.0	Dark buff	Steel hard, vitrified	
38	Brown, plastic clay	27.5	Good plasticity, works well	20 +	2790	Cracked in rapid drying	9.3	06	2.0	13.4	Dark cream	Hard	Semi-fire clay; possible use, if blended for stoneware and structural products
								03	4.0	9.3	Light buff	Very hard	
								6	5.0	5.8	Light buff	Very hard	

TABLE 15

Locality 15.....L.S. 1, Sec. 9, Tp. 8, R. 4, W.4th—Two miles northwest of Eagle Butte P.O.

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
39	Light grey clay	29.5	Good plasticity, works well	15	2570	Slightly cracked in rapid drying	8.0	06	2.7	13.9	Dark cream	Hard	Tender drying, stoneware clay
								03	7.7	0.9	Buff	Steel hard	
								1	9.7	0.0	Brownish buff	Vitrified	

TABLE 16

Locality 16.....L.S. 1, Sec. 9, Tp. 8, R. 4, W.4th—Two miles northwest of Eagle Butte P.O.

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
40	Very calcareous, buff coloured, bentonitic clay	25.0	Very plastic, slightly tough	4	2130	Cracked in rapid drying	8.3	08	0.0	12.7	Dark salmon	Fairly hard	Suitable for face brick
								06	0.3	12.8	Light red	Hard	
								03	1.8	7.4	Red	Very hard	
41	Brownish-buff, bentonitic clay	19.7	Very plastic, sticky	14.5	2550	Cracked in slow drying	12.1	03	4.6	5.5	Light brown	Hard	Doubtful if it could be used in clay products
								1	5.0	3.6	Brownish red	Steel hard	
								6	5.6	3.0	Red	Steel hard	
42	Light cream coloured clay	27.2	Good plasticity, works very well	16	2650	Cracked in rapid drying	7.6	1	6.5	2.0	Buff	Steel hard	Suitable for flue lining, sewer pipe, and face brick
								6	7.4	1.7	Dark buff	Steel hard	
								10	6.7	0	Grey	Vitrified	
43	Dark cream coloured clay	29.7	Very plastic, works well	14	2535	Cracks badly in rapid drying	8.6	03	7.0	0.8	Buff	Steel hard	Suitable for sewer pipe flue lining, and face brick
								1	8.0	0.1	Dark buff	Steel hard	
								6	8.5	0.0	Brownish buff	Vitrified	
44	Light brownish-grey clay	25.7	Very plastic, somewhat sticky, slightly gritty, works fairly well	18 +	2720	Cracks badly in rapid drying	10.4	1	1.0	11.6	Light buff	Fairly hard	Possible use for face brick by dry press method
								6	3.4	6.2	Light salmon	Hard	
								10	4.6	2.1	Light brown	Steel hard, nearly vitrified	

TABLE 17

Locality 17.....L.S. 16, Sec. 4, Tp. 8, R. 4, W.4th—One and one-half miles northwest of Eagle Butte P.O.

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
45	Light grey clay	31.2	Very plastic, works well	14.5	2550	Cracked very badly in rapid drying	8.4	06	3.0	12.2	Dark cream	Hard	Tender drying, stoneware clay
								03	7.8	0.6	Buff	Steel hard	
								1	8.0	0.1	Dark buff	Steel hard, vitrified	
46	Brownish-grey clay	30.5	Good plasticity, works well	16	2640	Cracks badly in rapid drying	10.0	06	2.0	12.7	Salmon buff	Hard	Tender drying, stoneware clay, but more open firing than No. 45
								03	4.3	7.3	Buff	Very hard	
								1	6.4	3.5	Salmon	Steel hard	

TABLE 18

Locality 18——L.S. 4, Sec. 2, Tp. 8, R. 4, W.4th—One mile northwest of Eagle Butte P.O.

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
47	Plastic, buff-coloured clay	24.0	Fairly plastic, works well	12	2390	Cracked very badly in rapid drying	8.0	06	0.7	12.5	Light salmon	Fairly hard	Possibly useful if blended with No. 48
								03	4.7	3.5	Dark salmon	Very hard	
								1	5.4	0.5	Brownish red	Steel hard; near vitrification	
48	Light grey, sandy clay	23.4	Very short, poor workability	14	2535	Safe in rapid drying	4.7	1	1.0	14.3	Salmon	Very soft	Useful for blending, for example with Nos. 47 and 49
								6	2.2	11.0	Dark salmon	Fairly soft	
								10	6.2	1.2	Light brown	Steel hard; near vitrification	
49	Light grey, bentonitic clay	28.2	Very plastic, sticky	10	2300	Cracked badly in rapid drying	9.1	08	0.7	13.6	Light salmon	Fairly hard	Suitable for face brick
								03	7.9	0.1	Brownish red	Steel hard	

TABLE 19

Locality 19.....L.S. 4, Sec. 2, Tp. 8, R. 4, W.4th—One mile northwest of Eagle Butte P.O.

No. Sample	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
50													
	Light buff coloured, bentonitic clay	26.2	Very plastic, slightly sticky	9	2280	Slightly cracked in air drying	11.3	08	0.0	10.6	Light salmon	Fairly hard	Suitable for face brick
								03	5.0	2.2	Dark red	Steel hard	
								1	5.6	0.7	Dark red	Vitrified	
51	Dark cream coloured, bentonitic clay	29.5	Very plastic, rather sticky	10	2300	Cracks very badly in rapid drying	10.3	08	0.4	11.7	Light salmon	Fairly hard	Possible use for structural products and quarry tile
								03	6.5	0.3	Brownish red	Steel hard	
								1	.....	0.1	Dark red	Vitrified, warped in firing	

TABLE 20

Locality 20.....L.S. 14, Sec. 35, Tp. 7, R. 4, W.4th—One-half mile northwest of Eagle Butte P.O.

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
52	Light buff, bentonitic clay	30.0	Very plastic, slightly sticky	9	2280	Cracks very badly in rapid drying	10	08	0.0	13.1	Light salmon	Fairly hard	Possible use for structural products
								06	1.3	11.5	Salmon	Hard	
								03	7.4	0.2	Brownish red	Steel hard, nearly vitrified	
53	Light buff, slightly bentonitic clay	23.1	Slightly gritty, fairly plastic, works fairly well	11	2340	Cracks badly in rapid drying	7.9	03	2.2	6.6	Light red	Hard	Suitable for structural products
								1	5.0	2.7	Light brownish red	Very hard	
								6	6.0	2.8	Light brownish red	Very hard	
										9.5	Salmon	Fairly hard,	Doubtful value for manufacture of clay products
54	Buff coloured, bentonitic clay	22.8	Very plastic, sticky	9	2280	Cracks in slow drying	7.7	06	0.0	4.0	Red	Very hard, cracked	
								03	3.2				
								1	5.7	1.2	Dark red	Vitrified in firing	

TABLE 21

Locality 21.....L.S. 2, Sec. 2, Tp. 8, R. 4, W.4th—One-half mile northwest of Eagle Butte P.O.

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
55	Light buff, bentonitic clay	26.0	Very plastic, somewhat sticky	13	2460	Cracked very badly in rapid drying	9.0	06	1.4	11.0	Light salmon	Fairly hard	Possible use for quarry tile and structural products
								03	4.8	3.3	Salmon	Very hard	
								1	7.3	0.3	Light brownish red	Steel hard	
56	Light buff, bentonitic clay	26.5	Very plastic, slightly sticky, poor workability	11	2360	Cracked very badly in rapid drying	8.7	06	0.6	10.0	Salmon	Fairly hard	Possible use for quarry tile and structural products
								03	3.7	4.0	Light red	Very hard, light scum	
								1	5.8	0.4	Dark red	Vitrified	

TABLE 22

Locality 22.....L.S.2, Sec. 2, Tp. 8, R. 4, W.4th—One-half mile northwest of Eagle Butte P.O.

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
57	Light buff coloured clay	26.5	Very plastic, sticky, poor workability	11	2345	Cracked badly in rapid drying	9.2	06	1.1	11.8	Light salmon	Fairly hard	Possible use for structural products if blended with non-plastic material
								1	6.0	6.5	Brownish red	Very hard	
								6	6.3	0.2	Brown	Vitrified	
58	Greyish buff clay	31.0	Very plastic, sticky	10	2300	Cracked very badly in rapid drying	10.0	06	1.0	12.6	Light salmon	Fairly hard	Possible use for quarry tile and structural products
								03	7.2	0.3	Brownish red	Steel hard	
								1	.....	0.0	Dark red	Vitrified, warped in firing	

TABLE 23

Locality 23.....L.S. 1, Sec. 7, Tp. 8, R. 3, W.4th—One and one-half miles south of Fly lake

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
59	Siliceous, white, silty, kaolinitic clay		Plasticity only fair, short			Favourable	6.3	010	.....		.....		Possible use for sewer pipe and fire proofing materials if blended with more plastic clays
								02	1.1		Light cream		
								6	4.2		Creamy yellow		
60	Mixture of white and yellow silt, white and light grey clay		Fair plasticity, short			Favourable	6.3	010	.....		.....		Possible use for sewer pipe and fire proofing materials if blended with more plastic clays
								02	0.0		Cream		
								6	2.8		Light buff		

TABLE 24

Locality 24.....L.S. 2, Sec. 6, Tp. 8, R. 3, W.4th—East side of Medicine Lodge coulee

No. Sample	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
61	Light grey, slightly bentonitic clay	24.1	Very plastic, works fairly well	13	2460	Cracked badly in rapid drying	7.5	06	1.0	10.9	Salmon buff	Hard	Suitable for face brick; might take a salt glaze
								03	3.4	7.2	Salmon buff	Hard	
								1	5.3	0.8	Brown salmon	Steel hard	
62	Light brownish-buff clay	25.0	Highly plastic, tough, works well	13	2460	Cracked badly in rapid drying	8.6	06	1.3	11.6	Light red	Hard	Suitable for face brick
								03	3.4	7.5	Light red	Very hard	
								1	5.0	3.8	Fair red	Steel hard	
63	Cream coloured, silty clay	21.5	Fairly short, works fairly well	15	2570	Safe in rapid drying	5.5	1	-0.7*	14.3	Buff	Soft	Might be useful for blending with other clays to assist in drying
								6	1.0	10.4	Buff	Fairly soft	
								10	4.5	3.4	Pinkish buff	Very hard	
64	Dark brown clay	28.1	Highly plastic, tough, works fairly well	16	2640	Cracked very badly in rapid drying	10.0	06	1.0	11.9	Light salmon buff	Hard	Suitable for building tile and face brick
								03	2.5	8.7	Salmon buff	Hard	
								10	4.7	2.4	Brown	Steel hard	

TABLE 24 (Continued)

Locality 24.....L.S. 2, Sec. 6, Tp. 8, R. 3, W.4th—East side of Medicine Lodge coulee

65	Pale grey, slightly calcareous clay	23.4	Fairly plastic, works well	13.5	2500	Safe in rapid drying	8.3	03	2.0	8.7	Salmon buff	Fairly hard, scummed	Slightly calcareous stoneware clay
								1	3.1	6.3	Salmon buff	Hard, slight scum	
								10	3.1	0.9	Grey	Vitrified	
66	Light grey clay	31.2	Very plastic, works fairly well	12	2390	Cracked very badly in rapid drying	10.3	06	1.3	10.1	Light salmon	Hard	Suitable for building brick and tile, and possibly for certain types of stoneware if treated for scumming
								03	3.7	0.2	Light red	Steel hard, badly scummed	
								1	6.7 *Expansion	0.1	Brownish red	Steel hard, scummed	

TABLE 25

Locality 25.....L.S. 2, Sec. 6, Tp. 8, R. 3, W.4th—East side of Medicine Lodge coulee

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
67	Light greyish-buff clay	23.1	Good plasticity, works well, gritty	14.5	2550	Cracked in rapid drying	7.9	06	0 0	12.0	Light salmon	Fairly hard	Should make a very good face brick
								03	1.9	9.3	Dark salmon	Hard	
								6	4.4	4.2	Red	Very hard	

TABLE 26

Locality 26.....L.S. 15, Sec. 31, Tp. 7, R. 3, W.4th—East side of Medicine Lodge coulee

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
68	Bentonitic, brown clay	26.7	Very plastic, tendency to be sticky, works fairly well, slightly gritty	28	2940	Cracks very badly in rapid drying	8.8	06	1.0	15.2	Light cream	Fairly hard	Dense firing semi-fireclay
								03	3.4	9.8	Dark cream	Hard	
								6	4.6	6.5	Dark cream	Steel hard	
								10	4.4	4.2	Grey	Steel hard	
69	Pale grey clay	25.0	Good plasticity, works well, slightly tough	14.5	2550	Cracks badly in rapid drying	7.6	06	0.0	14.9	Cream	Fairly hard	Suitable for face brick, and possible use for sewer pipe and flue lining
								03	3.8	8.0	Buff	Very hard	
								6	6.3	1.2	Dark buff	Steel hard	

TABLE 27

Locality 27.....L.S. 16, Sec. 31, Tp. 7, R. 3, W.4th—East side of Medicine Lodge coulee

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
70	Light grey, sandy clay	22.0	Fairly plastic, works well	18	2700	Cracks in rapid drying	6.4	1	0.3	11.2	Light buff	Fairly soft	Semi-fireclay, possible use as stoneware clay if blended to correct cracking in drying
								6	1.3	9.4	Light buff	Fairly hard	
								10	4.5	3.0	Greyish buff	Very hard	
71	Pale grey clay	25.0	Very plastic, slightly gritty, works fairly well	15	2460	Cracks very badly in rapid drying	7.3	06	0.6	10.4	Light salmon	Hard	Suitable for face brick, but colour is unique; possible use fore stoneware and flue lining
								03	4.0	3.9	Light buff	Hard	
								6	4.3	0.5	Brown	Steel hard	

TABLE 28

Locality 28.....L.S. 16, Sec. 31, Tp. 7, R. 3, W.4th—East side of Medicine Lodge coulee

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
72	Grey clay	25.0	Very plastic, works fairly well	14	2535	Cracks badly in rapid drying	7.5	06	0.7	11.8	Light salmon	Fairly hard	Suitable for face brick, but colour is unique; possible use for sewer pipe and flue lining
								03	4.3	6.0	Light buff	Very hard	
								6	6.0	0.1	Light brown	Steel hard	

TABLE 29

Locality 29.....L.S. 8, Sec. 31, Tp. 7, R. 3, W.4th—East side of Medicine Lodge coulee

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
73	White, siliceous, kaolinitic, silty clay		Fair plasticity, slightly short			Safe in rapid drying	4.2	010	.....		Light cream		Too siliceous to be used alone, but might be useful in blending
								02	2.1		Deep yellow buff		
								5	6.3		Light brown. poor		
74	Siliceous, silty shale		Plastic, but quite sticky			Safe in rapid drying	6.3	010	.....		Light red		Possible use for brick by the dry press method
								02	4.2		Light red		
								5	6.3		Dark red, over-fired		
75	Dull green and grey shale and clay		Plastic, somewhat sticky			Cracked in slow drying	6.3	010	.....		Light salmon		Possible use for brick by the dry press method
								02	4.2		Light red		
								5	8.3		Dark brown, over-fired		
76	Grey shale and clay, somewhat iron-stained		Good plasticity, sticky			Cracked in slow drying	8.3	010	.....		Light red		Possible use for brick by the dry press method
								02	6.3		Dark red		
								5	2.1		Dark red, over-fired		

TABLE 30

Locality 30.....L.S. 11, Sec. 32, Tp. 7, R. 3, W.4th—East side of Medicine Lodge coulee

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
77	Cream coloured clay	26.8	Very plastic, slightly sticky, works fairly well	16	2640	Cracked badly in rapid drying	9.2	1 6 10	0.8	11.8	Light salmon	Fairly hard, slightly warped	Possible use for dry pressed bricks; might take a salt glaze; impure stoneware type clay
									5.5	3.0	Dirty salmon	Very hard, slightly warped	
									.....	0.3	Grey	Vitrified, slightly warped	

TABLE 31

Locality 31.....L.S.2, Sec. 32, Tp. 7, R. 3, W.4th—East side of Medicine Lodge coulee

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
78	Light buff coloured, calcareous, silty clay	26.0	Rather short, works fairly well	12	2390	Safe in rapid drying	6.2	1	-0.3*	17.5	Light salmon	Soft, light scum	Suitable for structural products; might take a salt glaze if blended with some overlying beds
								6	3.4	9.2	Buff	Hard, light scum	
								10	4.3	1.3	Grey	Vitrified, over-fired	
									*Expansion				

TABLE 32

Locality 32.....L.S. 12, Sec. 25, Tp. 7, R. 4, W.4th—One mile south of Eagle Butte P.O.

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
79	Grey clay	25.3	Good Plasticity, works well	14	2535	Slight cracking in rapid drying	6.4	06	0.7	14.1	Dark cream	Fairly hard	Stoneware clay
								03	2.3	8.3	Dark cream	Hard	
								1	8.0	0.0	Dark buff	Steel, hard, vitrified	

TABLE 33

Locality 33.....L.S. 6, Sec. 25, Tp. 7, R. 4, W.4th—One mile south of Eagle Butte P.O.

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
80	Light grey clay	26.5	Good plasticity, works well	15	2570	Cracked badly in rapid drying	8.4	06	0.3	14.8	Light salmon	Fairly soft	Suitable for dry pressed brick; possible use for stoneware if blended
								03	1.8	10.5	Light buff	Fairly hard	
								1	5.0	5.0	Salmon buff	Very hard	
81	Dark brown clay	30.0	Good plasticity, works well, slightly tough	16	2640	Cracked badly in slow drying	11.7	06	-1.7*	12.3	Salmon	Hard	Possible use for dry pressed brick
								03	3.0	8.0	Salmon	Hard	
								1	5.3 *Expansion	7.6	Pinkish red	Very hard	

TABLE 34

Locality 34.....L.S. 16, Sec. 24, Tp. 7, R. 4, W.4th—One and one-half miles southeast of Eagle Butte P.O.

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
82	Grey, calcareous clay	26.2	Good plasticity, works well	16	2640	Cracked badly in rapid drying	9.2	03	6.0	6.2	Light buff	Hard	Possible use for structural products
								6	4.7	2.4	Buff	Steel hard	
83	Light buff coloured, calcareous, bentonitic clay	31.2	Very plastic, sticky	11	2340	Cracked in slow drying	12.0	06	0.6	10.4	Light buff	Hard	Possible use for dry pressed brick
								03	2.4	5.0	Light salmon	Very hard	
								1	5.3	0.8	Brownish buff	Steel hard, warped in firing	

TABLE 35

Locality 35.....L.S. 1, Sec. 25, Tp. 7, R. 4, W.4th—One and one-half miles southwest of Eagle Butte P.O.

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
84	Light grey, bentonitic clay	30.6	Very plastic, slightly sticky	18	2700	Cracked very badly in rapid drying	12.4	06	1.3	9.2	Light buff	Hard	Tender drying, stoneware type clay
								03	2.3	5.8	Buff	Very hard	
								6	4.7	1.9	Dirty buff	Steel hard	
85	Cream coloured clay	26.6	Good plasticity, works well	15	2570	Cracked in rapid drying	8.7	03	2.2	9.6	Light buff	Hard	Clean burning stoneware clay
								6	5.8	3.3	Buff	Very hard	
								10	6.0	0.0	Grey	Vitrified	
86	Cream coloured clay	23.5	Good plasticity, works well	15	2570	Cracks badly in rapid drying	8.7	03	2.0	8.0	Light buff	Hard	Clean burning, tender drying, stoneware clay
								6	4.4	5.0	Buff	Very hard	
								10	4.7	0.5	Light grey	Vitrified	
87	Slighty bentonitic, cream coloured clay	28.8	Very plastic, slightly sticky, works fairly well	15	2570	Cracks very badly in rapid drying	10.0	06	1.3	10.8	Light salmon	Hard	Possible use for brick, tile and other structural products, but colour is poor for face brick
								03	3.0	5.7	Salmon	Very hard	
								1	6.0	0.1	Brownish red	Vitrified	

TABLE 35 (Continued)

Locality 35.....L.S. 1, Sec. 25, Tp. 7, R. 4, W.4th—One and one-half miles southwest of Eagle Butte P.O.

88	Slightly bentonitic clay	26.0	Very plastic, sticky	14	2535	Cracked badly in rapid drying	10.2	06	0.7	9.8	Light salmon	Hard	Possible use for structural products, but colour is poor for face brick; may make dry pressing quarry tile
								03	1.8	6.2	Light salmon	Very hard	
								1	5.0	0.3	Brownish red	Steel hard	
89	Brown, tough clay	36.8	Very plastic, works fairly well	20 +	2790	Cracked very badly in rapid drying	14.8	06	3.3	11.1	Buff	Hard, cracked in firing	Value is doubtful for manufacture of ceramic products
								03	4.2	5.9	Buff	Very hard, cracked	
								1	7.3	1.9	Salmon	Steel hard, cracked	
90	Light buff coloured bentonitic clay	30.9	Very plastic, slightly sticky	15	2570	Cracked very badly in rapid drying	12.5	06	0.6	10.8	Light buff	Fairly hard	Possible use for face brick by dry press method
								03	1.6	7.2	Light salmon	Hard	
								1	3.6	4.5	Light red	Very hard	
91	Very sandy clay	19.9	Very short, sandy, poor workability	15	2570	Safe in rapid drying	2.5	1	-1.2*	15.5	Buff	Very soft	No value if used alone; possible use in blending
								6	0.7	12.0	Buff	Fairly soft	
								10	2.7	6.6	Salmon grey	Hard	
92	Dark, cream coloured clay	29.3	Good plasticity, works well	11	2340	Cracked badly in rapid drying	9.7	08	0.0	12.5	Light salmon	Fairly hard	Possible use for structural products, short firing range
								06	2.3	9.5	Salmon	Hard	
								03	7.5	0.0	.....	.....	

*Expansion

TABLE 36

Locality 36.....L.S. 8, Sec. 34, Tp. 7, R. 3, W.4th—East side of Medicine Lodge coulee

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
93	Light grey, calcareous, bentonitic clay	38.7	Very plastic, sticky	4	2130	Cracked in slow drying	14.0	06	1.7	12.7	Salmon	Hard, cracked	Possible use for structural products if blended with No. 94
								03	1.5	13.2	Pink	Hard, cracked	
								1	1.7	11.0	Dark pink	Hard, cracked	

TABLE 37

Locality 37.....L.S. 8, Sec. 34, Tp. 7, R. 3, W.4th—East side of Medicine Lodge coulee

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
94	Grey buff, sandy, calcareous clay	25.0	Very short, poor workability	14	2535	Safe in rapid drying	6.7	1	-0.4*	17.0	Light salmon	Very soft	Unsuitable for use alone, but could possibly be used for structural products if blended with No. 93
								6	2.2	11.6	Dark salmon	Fairly soft	
								10	6.9 *Expansion	1.2	Light brown	Vitrified	

TABLE 38

Locality 38.....L.S. 11, Sec. 18, Tp. 7, R. 2, W.4th—On Thelma creek two miles south of Thelma P.O.

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Colour	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
95	Grey clay	31.8	Highly plastic, works well	18	2700	Cracked very badly in rapid drying	11.0	1	5.0	5.3	Buff	Very hard	Suitable for stoneware; tender drying
								6	5.3	5.2	Darker buff	Very hard	
								10	6.0	.....	Dark grey	Steel hard	
96	Pale grey clay	26.2	Good plasticity, works well	16	2640	Cracked badly in rapid drying	9.7	1	1.4	11.0	Light buff	Fairly hard	Tender drying, stoneware clay
								6	4.4	5.1	Buff	Very hard	
								10	5.8	0.5	Grey	Vitrified	
97	Cream coloured, bentonitic clay	26.2	Good plasticity, works well	15	2570	Cracked badly in rapid drying	9.0	06	0.7	13.8	Buff	Fairly hard	Suitable for structural products, but colour is poor; might take a salt glaze
								03	4.0	7.0	Salmon buff	Hard	
								1	5.7	2.5	Dirty buff	Steel hard	

TABLE 38 (Continued)

Locality 38.....L.S. 12, Sec. 18, Tp. 7, R. 2, W.4th.—On Thelma creek two miles south of Thelma P.O.

98	Dark brown clay	31.0	Very plastic, tough, works well	27	2920	Cracked very badly in rapid drying	11.2	03	4.3	9.5	Buff	Hard	Semi-fireclay
								1	7.3	6.5	Buff	Very hard	
								6	6.7	6.0	Buff	Very hard	
99	Cream-coloured clay	26.6	Highly plastic, works fairly well	14.5	2550	Cracked in rapid drying	9.3	03	3.4	6.8	Buff	Hard	Suitable for face brick and tile, and possibly sewer pipe
								1	5.3	3.1	Buff	Steel hard	
								6	5.4	2.3	Dirty buff	Steel hard	
100	Pale grey, bentonitic clay	26.5	Very plastic, slightly sticky, works fairly well	13	2460	Cracked very badly in rapid drying	9.3	03	4.0	4.8	Salmon	Very hard	Suitable for structural products, and possibly sewer pipe
								1	6.0	0.6	Brown	Steel hard	
								6	6.5	0.5	Dark brown	Steel hard, vitrified	

TABLE 39

Locality 39.....L.S. 6, Sec. 18, Tp. 7, R. 2, W.4th—On Thelma creek, two miles south of Thelma P.O.

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
101	Dark brown shale	36.2	Highly plastic, tough	30	3000	Cracked very badly in rapid drying	12.0	06	3.7	13.2	Buff	Hard	Fireclay
								6	7.7	6.6	Buff	Very hard	
								10	7.7	5.6	Brown salmon	Steel hard	
102	Brown coloured shale	35.0	Very plastic, works well, tough	28 +	2950	Cracked badly in rapid drying	12.8	06	3.0	12.6	Buff	Hard	Semi-fireclay
								6	7.0	4.6	Buff	Very hard	
								10	7.0	2.8	Light brown	Steel hard	
103	Pale grey, bentonitic clay	30.0	Very plastic, sticky, works well	15	2570	Cracked badly in rapid drying	11.0	06	0.7	13.5	Light buff	Fairly hard	Early maturing type of stoneware clay requiring the addition of non-plastic material to prevent cracking
								03	5.3	4.2	Buff	Very hard	
								1	7.3	1.4	Brownish buff	Steel hard	

TABLE 40

Locality 40.....L.S. 8, Sec. 5, Tp. 7, R. 1, W.4th—Two and one-half miles south of Fox P.O.

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
104	Grey, calcareous clay	24.1	Good plasticity, works well	13	2460	Cracked badly in rapid drying	8.3	06	1.0	11.3	Light salmon	Hard, scummed	Possible use for dry pressed brick
								03	5.7	3.0	Buff	Very hard, badly scummed	
								1	5.7	0.1	Brownish buff	Steel hard, vitrified	
105	Grey clay	26.5	Very plastic, somewhat sticky	13	2460	Cracked badly in slow drying	9.6	06	0.3	8.3	Salmon	Fairly hard	Possible use for dry pressed brick and quarry tile
								03	2.9	3.7	Light red	Very hard, scummed	
								1	4.0	2.3	Brownish red	Steel hard	
106	Grey clay	25.5	Good plasticity, works well	11	2340	Cracked in rapid drying	8.1	06	1.0	12.0	Light salmon	Fairly hard, scummed	Suitable for common brick and tile; possible use for stoneware
								1	7.3	0.4	Brown	Steel hard	
								6	7.0	0.3	Dark brown	Vitrified	

TABLE 40 (Continued)

Locality 40.....L.S. 8, Sec. 5, Tp. 7, R. 1, W.4th—Two and one-half miles south of Fox P.O.

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
107	Buff colored clay	22.5	Fair plasticity, works well, silty	9	2280	Cracked in rapid drying	7.3	03	2.7	6.0	Light red	Hard, slight scum	Suitable for building brick and tile if dried slowly
								1	5.3	0.9	Dark red	Steel hard	
								6	5.9	0.8	Brownish red	Vitrified	
108	Grey clay	28.4	Highly plastic, works well	9	2280	Cracked badly in rapid drying	10.0	06	5.7	0.9	Dark salmon	Hard	Suitable for building brick and tile if cracking can be prevented
								03	6.8	0.0	Brownish red	Vitrified, scummed	
								1	.....	.....	Dark red	Overfired	

TABLE 41

Locality 41.....L.S. 8, Sec. 31, Tp. 7, R. 3, W.4th—Two and one-half miles south of Fox P.O.

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
109	Pale grey, calcareous clay	25.2	Very plastic, works well	12	2390	Cracked in rapid drying	8.8	08	0.0	11.9	Light salmon	Fairly soft	Suitable for building brick and tile; possible use for certain types of stoneware
								03	3.0	6.8	Salmon	Fairly soft	
								1	1.0	1.9	Brownish salmon	Steel hard	
110	Tough, brown clay	34.4	Very plastic, works fairly well, rather tough	26	.....	Cracks very badly	12.1	06	1.7	11.1	Light buff	Hard	Tender drying, very dense semi-fireclay
								03	4.7	6.6	Light buff	Very hard	
								10	6.7	1.0	Dark grey	Steel hard	
111	Light grey clay	30.5	Highly plastic, works well	13	2460	Cracks in rapid drying	8.6	06	1.0	12.9	Light buff	Fairly hard, warped	Suitable for structural products; should take a salt glaze
								03	5.3	5.5	Buff	Very hard, warped	
								1	6.7	0.0	Dark buff	Steel hard, warped	
112	Pale grey, slightly calcareous clay	24.5	Rather short, works fairly well	15	2570	Safe in rapid drying	6.5	1	2.0	6.5	Dark cream	Hard	Short stoneware clay
								6	2.7	6.2	Dark cream	Hard	
								10	6.0	0.6	Light grey	Vitrified	

SUMMARY AND CONCLUSIONS

There are deposits of stoneware clay, fire clay and other high grade clays in the Whitemud formation of the Cypress hills in Alberta. Recovery of the clays should be simple, since all deposits are easily accessible, many have a relatively light overburden, and these may be won by open pit methods of mining. Their development is dependent principally upon the cost of transportation. Large motor trucks, taking advantage of the downhill grade to Medicine Hat, may be the solution to this problem.

Clays of one type are not confined to one locality but may occur anywhere in the map-area. In general, though, the quality of the clays and the thickness of the beds increases eastwards towards the Alberta-Saskatchewan boundary. However, the deposits in the western part of the map-area offer the best possibilities for recovery for they have the lighter overburden.

The ceramic properties of the clays, as shown in the tables, have been determined by preliminary tests of the raw samples. These properties could be improved in many instances by simple treatment of the clays.

Kaolinized sands are present and offer possibilities as a source of kaolin.

No ball clays were observed in any of the outcrops examined.

Chapter IV

BIBLIOGRAPHY

Allan, J. A. and Sanderson, J. O. G.: Geology of Red Deer and Rosebud Sheets, Alberta; Research Council, Alberta, Report 13 (1945).

Alden, W. C.: Physiography and Glacial Geology of Eastern Montana and Adjacent Areas; U.S. Geol. Surv., Prof. Pap. 174, 1932.

Berry, E. W.: Fossil Plants from the Cypress hills of Alberta and Saskatchewan; Nat. Mus., Canada, Bull. 63, pp. 15-32 (1930).

———Floras of the Whitemud and Ravenscrag Formations; Geol. Surv., Canada, Mem. 182, 1935.

Crockford, M. B. B.: Private Reports to the California Standard Co. (1944-45).

———Preliminary Report on the Ceramic Importance of Clay and Shale Deposits of Alberta; Research Council, Alberta, Mimeographed Circular No. 3 (1947).

Davis, N. B.: Report on the Clay Resources of Southern Saskatchewan; Dept. of Mines, Canada, Mines Branch, No. 468, 1918.

Dowling, D. B.: The Southern Plains of Alberta; Geol. Surv., Canada, Mem. 93, 1917.

Dyer, W. S.: Geological Structure in the Western End of the Cypress Hills, Alberta· Geol. Surv., Canada, Sum, 1926, pt. B, pp. 15-38 (1927).

Furnival, G. M.; Cypress Lake Map-area, Saskatchewan; Geol. Surv., Canada, Memoir 242, 1946.

Fraser, F. J.: McLearn, F. H., Russell, L. S., Warren, P. S., and Wickenden, R. T. D.: Geology of Southern Saskatchewan; Geol. Surv., Canada, Mem. 176, 1935.

Keele, J.: Clay and Shale Deposits of the Western Provinces, Geol. Surv., Canada, Memoir 66, 1915.

Lines, F. G.: Private Report to the California Standard Co. (1945).

McConnell, R. G.: Report on the Cypress Hills, Wood Mountain and Adjacent Country; Geol. Surv., Canada, Ann. Rept. 1885, pt. C.

McLearn, F. H.: Stratigraphy, Structure, and Clay Deposits of Eastend Area, Cypress Hills, Saskatchewan; Geol. Surv., Canada, Sum. Rept. 1927, pt. B, pp.21 -53 (1928).

———Southern Saskatchewan; Geol. Surv., Canada, Sum. Rept. 1928, pt. B, pp. 30-44 (1929).

———Stratigraphy, Clay and Coal Deposits of Southern Saskatchewan; Geol. Surv., Canada, Sum. Rept. 1929, pt. B, pp. 48-63 (1930).

———Some Clay Deposits of Willowbunch Area, Saskatchewan: Geol. Surv., Canada, Sum. Rept. 1930, pt. B, pp. 31-49 (1931).

McLearn, F. H., and McMahon, J. F.: Buff and White-burning Clays of Southern Saskatchewan; Geol. Surv., Canada, Sum. Rept. 1933, pt. B, pp. 32-155 (1934).

Ries, H.: Clay and Shale Deposits of the Western Provinces (Pt IV). Geol. Surv., Canada, Mem. 65, 1915.

Ries, H., and Keele, J.: Clay and Shale Deposits of the Western Provinces; Geol. Surv., Canada, Mem. 24-E, 1912.

———Clay and Shale Deposits of the Western Provinces (Pt II); Geol. Surv., Canada, Mem. 25, 1916.

Romine, T. B.: Oil Fields and Structure of Sweetgrass Arch, Montana; Bull. Amer. Assoc. Pet. Geol., vol. 13, No. 7, pp. 779-797 (1929).

Russell, L. S.: The Cretaceous-Tertiary Transition of Alberta; Trans. Roy. Soc., Canada, 3rd ser., vol. 26, sec. 4, pp. 121-156 (1933).

———Correlation of the Cretaceous-Tertiary Transition in Saskatchewan and Alberta; Geol. Soc. Am. Bull., vol. 61, pp. 27-42 (1950).

———Land and Sea Movements in the Late Cretaceous of Western Canada; Trans. Roy. Soc., Canada, 3rd Ser., sec. 4, Vol. 33, 1939.

Russell, L. S., and Landes, R. W.: Geology of the Southern Alberta Plains; Geol. Surv., Canada, Mem. 221, 1940.

Sanderson, J. O. G.: Upper Cretaceous Volcanic Ash Beds in Alberta. Trans. Roy. Soc., Canada, 3rd Ser., vol. 25, sec. 4, pp. 61-70 (1931).

———Foxhills Formation in Southern Alberta; Amer. Assoc. Pet. Geol., vol. 15, pp. 1251-1263 (1931). Comments by J. S. Irwin.

Stanton, T. W.: Correlation of Western Upper Cretaceous Formations; U.S. Geol. Surv., Prof. Pap. 120, p. 167 (1919).

Williams, M. Y., and Dyer, W. S.: Geology of Southern Alberta and Southwestern Saskatchewan; Geol. Surv., Canada, Mem. 163, 1930.

Worcester, W. G.: Saskatchewan Clays of Dominion Importance; Trans. Can. Inst. Min. Met., vol. 32, pp. 255-269 (1929).

———The Industrial Processing of Western Canadian Fire Clays; Trans. Can. Inst. Min. Met., 1942.

APPENDIX I

DESCRIPTIONS OF OCCURRENCES

Following the survey in the Cypress hills, examinations were made of some clays of reported high quality elsewhere in southern Alberta. The descriptions of occurrences are given below. The results of the ceramic tests of samples collected follow the descriptions of occurrences.

LOCALITY 42

In a road cut on the south side of the valley in Sec. 4, Tp. 11, R. 4, W. 4th Mer., near Norton P.O.

Bearpaw Formation

Shale, grey, marine, thickness not measured, but at least 15 feet (Sample 113).

This shale was deposited during an invasion of the sea. It is practically unlimited in quantity since it extends over wide areas in this part of the province and, furthermore, may be obtained very close to the main line of the Canadian Pacific Railway. The clay scums on firing, but should this defect be overcome a new and vast supply of clay will be opened up. The above sample was taken from near the base of the Bearpaw formation.

The results of tests on the sample are given in Table 42, page 97.

LOCALITY 43

Two shale pits on the southern edge of the town of Blairmore, in Sec. 35, Tp. 7, R. 4, W. 5th Mer.

Fernie Formation

Shale, dark grey, marine, fossiliferous; formerly used for making bricks. (Sample 114).
Shale, as above; formerly used in making cement (Sample 115).

Utilization of these shales was discontinued for economic reasons, principal of which was the distance to markets. Shales of similar age occur abundantly in the front ranges of the Rocky Mountains.

The results of tests on these samples are given in Table 43, page 97.

LOCALITY 44

On the northern edge of the town of Frank and in Sec. 31, Tp. 7, R. 3, W. 5th Mer.

Blairmore Formation

Shale, green, sandy (Sample 116).
Shale, as above, and from the lower part of section (Sample 117).

The strata dip steeply westwards. These shales were formerly used in brickmaking, but their use was discontinued for economic reasons.

The results of the tests on these samples are given in Table 44, page 98.

LOCALITY 45

On the north side of Crowsnest River valley, north of Passburg, and in Sec. 16, Tp. 7, R. 3, W. 5th Mer.

Blairmore Formation

Shale, quite sandy, green, blocky, thickness not measured (Sample 118).

These shale beds dip steeply westwards. They are reported to have been used in brickmaking at one time.

The results of the tests on this sample are given in Table 45, page 98.

LOCALITY 46

On the south side of Crowsnest River valley at Passburg, and in L.S. 15, Sec. 10,, Tp. 7, R. 3, W. 5th Mer.

	Thickness Feet
Blairmore Formation	
Shale, greenish-grey, sandy, blocky (Sample 119)	10.0

Shales collected from this vicinity are reported to be suitable for the making of sewer pipe (Ries, 1915). A diligent search by the writer failed to reveal the pits from which the samples were taken.

The above sample taken by the writer was found in tests to possess the properties for an excellent face brick. Should the shale be quarried for this purpose, winning and transportation will not be difficult for there is no overburden, and an inexpensive road can easily be built to the deposit.

The results of the tests on this sample is given in Table 46, page 99.

LOCALITY 47

On the south side of Crowsnest River valley south of Passburg, and in Sec. 11, Tp. 7, R. 3, W. 5th Mer.

	Thickness Feet
Blairmore Formation	
Shale, greenish-grey, sandy, blocky (Sample 120)	12.0
Shale, greyish-green, sandy; taken about 50 feet stratigraphically below Sample 120 (Sample 121).	

These shales appear similar in outcrop to that at locality 46. However, they do not possess all of its better working and burning qualities. This shows that Blairmore shales vary considerably in their possible application in ceramics.

The beds dip steeply westwards.

The results of the tests on these samples are given in Table 47, page 99.

LOCALITY 48

About one mile northwest of the town of Gleichen, and in L.S. 5, Sec. 24, ,Tp. 22, R. 23, W. 4th Mer.

	Thickness Feet
Glacial till	4.0
Edmonton Formation	
Shale, dark grey, resembles the Battle formation of Cypress hills (Sample 122)	35.4
Shale, sandy, greenish-grey, weathers pale grey (Sample 123)	4.0
Shale, sandy, green (Sample 124)	3.0
Total thickness	46.4

These beds are of interest since they could be readily won and transported. The strata are flat lying. Large quantities are present where the overburden is light. It is probable that the shales could be utilized if blended with shorter materials.

Results of the tests on these shales are given in Table 48, page 100.

LOCALITY 49

About six miles east of Drumheller at the mouth of Willow creek in Sec. 15, Tp. 28, R. 18, W. 4th Mer.

	Thickness Feet
Edmonton Formation	
Shale, pale grey, sandy (Sample 125)	12.0

This bed lies under an overburden of 30 feet of boulder clay. It was sampled in order to evaluate some of the shales of the Edmonton formation.

Results of the tests on this sample are given in Table 49, page 101.

LOCALITY 50

Along Red Deer river, seven miles east of Delburne in Sec. 23, Tp. 37, R. 22, W. 4th Mer.

	Thickness Feet
Edmonton Formation	
Shale, dark grey, quite bentonitic, resembles Battle formation	22.0
Shale, cream-coloured, silty in lower part, prominent light coloured band (Sample 126)	7.0
Shale, steel grey colour, weathers light bluish-grey, flaky (Sample 127)	2.6
Total thickness	31.6

These shales are very light coloured in outcrop, and hence quite conspicuous. Some persons have suggested that the colour is due to a kaolin content. Ceramic tests of the samples show that this assumption is unfounded.

Results of the tests on these samples are given in Table 50, page 101.

LOCALITY 51

Along Red Deer river, nine miles northeast of Delburne in Sec. 28, Tp. 38, R. 22, W. 4th Mer.

	Thickness Feet
Edmonton Formation	
Shale, dark grey, bentonitic	15.0
Shale, creamy weathering, sandy (Sample 128)	4.5
Sandstone, white weathering, argillaceous, bentonitic (Sample 129)	11.5
Total thickness	31.0

These beds were sampled in order to evalute their use in ceramics since their light colour had suggested the presence of kaolin. Though they have no value in the ceramic industry, the results of the tests are included here as a matter of record and are given on Table 51, page 102.

TABLES OF RESULTS

TABLE 42

Locality 42.....L.S. 16, Sec. 4, Tp. 11, R. 4, W.4th—Near NortonP.O., 15 miles southeast of Medicine Hat

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
113	Greyish-brown shale	31.6	Very plastic, tough and sticky, works fairly well	10	2300	Cracked badly in slow drying	13.1	06	1.7	10.9	Dark salmon	Hard, scummed	Fires to a fairly good brick color, but scums badly; doubtful value
								03	4.2	5.4	Light red	Very hard, scummed	
								1	4.7	1.4	Red	Steel hard, scummed	

TABLE 43

Locality 43.....Sec. 35, Tp. 7, R. 4, W.5th—Former shale pit at the cement plant, Blairmore

No. Sample	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
114	Dark brown, shale	20.3	Short, poor workability	12.5	2410	Safe in rapid drying	5.2	06	1.7	13.7	Light brownish red	Fairly hard	Suitable for face brick; workability could be improved by the addition of a more plastic clay
								03	3.3	10.0	Brownish red	Hard	
								1	6.0	5.9	Good red	Very hard	
115	Very calcareous, dark brown shale	20.3	Very plastic, works fairly well	2	2070	Very slight cracking in rapid drying	5.0	03	0.7	16.8	Dark cream	Fairly soft	Very short firing range; unsuited for ceramic products
								1	6.8	1.3	Greenish buff	Very hard	

TABLE 44

Locality 44.....Sec. 31, Tp. 7, R. 3, W. 5th—Abandoned shale pit at Frank

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
116	Dark brown, very calcareous, sandy shale	18.0	Short, works fairly well	8	2240	Some cracking in rapid drying	4.4	1	-3.3*	42.0	Pale grey	Very soft	Unsuited for ceramic products, but could possibly be used if blended with No. 117
								6	4.6	19.5	Pale grey	Fairly hard	
117	Brownish-buff shale	19.1	Good plasticity, works well	12	2390	Safe in rapid drying	4.9	03	3.0	6.5	Red	Hard	Should make an excellent face brick
								1	4.0	3.4	Red	Very hard	
									*Expansion				

TABLE 45

Locality 45.....Sec. 16, Tp. 7, R. 3, W.5th—Bedrock outcrop at Passburg, north of highway

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
118	Greyish-buff. sandy shale	15.1	Very short, sandy, poor workability	9	2280	Safe in rapid drying	2.4	1	0.0	12.9	Brownish red	Soft	Unsuited for ceramic products
								6	3.0	6.6	Red	Hard	

TABLE 46

Locality 46.....L.S. 15, Sec. 10, Tp. 7, R. 3, W.5th—South side of valley at Passburg

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
119	Grey shale	17.2	Fairly plastic, works fairly well	6	2175	Safe in rapid drying	4.7	06	0.7	10.7	Light red	Fairly soft	Should make an excellent face brick
								03	2.5	6.9	Good red	Fairly hard	
								1	4.0	1.3	Dark red	Steel hard	

TABLE 47

Locality 47.....Sec. 11, Tp. 7, R. 3, W.5th—South side of valley at Passburg

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
120	Brownish-buff shale	16.4	Short, poor workability	6.5	2190	Safe in rapid drying	3.4	06	-0.3*	14.2	Light red	Soft	Possible use for brick by soft mud or dry press methods; could be improved by the addition of more plastic material
								1	4.0	3.4	Dark red	Steel hard	
								6	5.2	1.0	Dark red	Vitrified	
121	Dark brown shale	21.0	Fairly plastic, works well	5	2160	Slight cracking in rapid drying	5.5	06	1.0	13.8	Red	Fairly soft	Very short firing range; probably used if blended with No. 120
								03	3.7	8.1	Red	Hard	
								1	6.0	0.9	Dark red	Vitrified	
									*Expansion				

TABLE 48

Locality 48.....L.S. 5, Sec. 24, Tp. 22, R. 23, W.4th—One mile northwest of Gleichen

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
122	Dark brown, tough clay	46.2	Very tough, fair workability	15	2570	Cracked badly in slow drying	13.1	06	4.0	10.2	Salmon	Fairly hard	Doubtful value for ceramic products
								03	5.4	8.4	Dark salmon	Hard	
								1	7.0	6.9	Light brownish red	Very hard	
123	Brownish-grey, bentonitic clay	28.8	Very plastic, sticky	15	2570	Cracked in slow drying	8.5	06	1.0	13.3	Salmon buff	Fairly hard	Doubtful value for ceramic products
								03	2.2	10.4	Dark buff	Fairly hard	
								1	4.0	7.3	Salmon	Hard	
124	Grey, bentonitic clay	31.2	Very plastic, sticky, works fairly well	11	2340	Cracked badly in slow drying	9.9	06	4.3	11.3	Salmon	Hard	Doubtful value for ceramic products
								03	3.5	7.0	Dark salmon	Very hard	
								1	5.7	2.3	Red	Steel hard	

TABLE 49

Locality 49.....Sec. 15, Tp. 28, R. 18, W.4th—Mouth of Willow creek, east of Drumheller

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Drying Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
125	Tough, light brown clay	32.8	Very plastic, tough, works fairly well	10	2300	Cracked badly in slow drying	10.0	06	1.3	13.4	Dark salmon	Fairly hard	Value is doubtful for ceramic products since it cracks so badly
								1	6.0	2.2	Brownish red	Steel hard	

TABLE 50

Locality 50.....Sec. 23, Tp. 37, R. 22, W.4th—Along Red Deer river, east of Delburne

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Shrinkage Drying %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
126	Tough, dark grey clay	32.2	Very plastic, tough, works fairly well	9	2280	Cracked very badly in slow drying	.....	.....	Too badly cracked to fire	.....	.....	.....	No value for ceramic products
127	Light grey, bentonitic clay	30.3	Very plastic, sticky, fair workability	15	2570	Cracked very badly in slow drying	.....	.....	Too badly cracked to fire	.....	.....	.....	No value for ceramic products

TABLE 51

Locality 51.....Sec. 28, Tp. 38, R. 22, W.4th—Along Red Deer river, northeast of Delburne

Sample No.	Colour, Grade	Tempering Water %	Working Properties	P.C.E.	Approx. Temperature °F.	Drying Behaviour	Shrinkage %	Cone	Fire Shrinkage %	Absorption %	Colour	Hardness	Remarks
128	Very sandy, bentonitic clay	40.0	Sticky, very sandy, works fairly well	9	2280	Cracked in slow drying	3.5	1	0.4	18.8	Light brown	Soft	No value for ceramic products
								6	1.5	14.5	Light brown	Fairly hard	
129	Cream coloured, bentonitic clay	34.7	Highly plastic, sticky, poor workability	15	2570	Cracked very badly in slow drying		.....	Too badly cracked to fire	.....	.....	.....	No value for ceramic products