

NORTH DAKOTA GEOLOGICAL SURVEY

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**CLAYS OF NORTH DAKOTA AS A
POTENTIAL SOURCE OF ALUMINA**

by

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Abstract

Clays in several localities in North Dakota are known to contain in excess of 20% alumina. This investigation was an attempt to locate clay deposits of 20% or higher alumina content of sufficient size to supply an aluminum plant for at least twenty-five years. Samples collected were analyzed for alumina by the method of basic fusion of the clay followed by a pH titration. A plant to manufacture alumina from the clay by the lime-soda-sinter process would require a minimum deposit of 50 million tons of clay containing 20% or more Al_2O_3 in addition to an adequate supply of water, lignite, and limestone. No deposits meeting the requirements were found.

INTRODUCTION

Basic Raw Material for Alumina Manufacture

Bauxite is presently the only source of alumina for metal production and typical bauxites contain from 47 - 59% alumina (Materials Survey-Aluminum 1956, Chap. V, p. 1) (Cservenyak, 1947, p. 3).

Clay from South Carolina containing from 33-35% alumina was processed successfully in pilot plant tests in 1947 and alumina was produced from this clay at an estimated cost of \$47.96 per ton. In 1947 alumina produced by the Bayer process cost \$32.00 per ton (Materials Survey-Bauxite, 1953, Chap. VII, p. 5).

Four experimental plants were built during World War II to produce alumina from clays. One of them at Salem, Oregon used clays containing 30-35% alumina. These plants met with only limited success and are no longer operating, but in emergencies adequate supplies of aluminum could be made from clays by processes that have already been developed (Materials Survey-Bauxite, 1953, Chap. VII, pp.5-7).

In 1951 specifications for purchase of bauxite for the National Stockpile demanded a 55% minimum for alumina and a 5% maximum for silica. When these figures are compared with average analyses of North Dakota clays showing 20-25% alumina and 62-75% silica, the vast difference in grade becomes readily apparent.

Bauxite results from weathering of alumina-bearing rocks over a long period of time under conditions of climate which favor solution and removal of silica. The final product is essentially silica-free aluminum oxide with a certain amount of combined water. Deposits of this type of material are found in Alabama, Arkansas, and Georgia in the United States and in a number of foreign countries.

Clays are also products of weathering for long periods of time, but the final product instead of being almost free of silica is a compound of water, alumina, and silica. Kaolinite for example is about 39% alumina and 46% silica. North Dakota clay deposits are mixtures of various clays containing large amounts of free silica in the form of sand so that analyses usually show a silica-alumina ratio of about 3 to 1.

Purpose of Investigation

In June, 1957 the North Dakota Geological Survey was advised that a large aluminum company was interested in the possibility of manufacturing aluminum in North Dakota. The minimum requirements for the construction of an aluminum plant were set at 50 million tons of clay containing in excess of 20% alumina with adequate supplies of water, lignite and limestone nearby.

It was recognized at the outset that all these conditions could not be met, but the project was undertaken with the idea that perhaps all but one of the raw materials could be obtained in the same general locality.

Previous Work

In 1906 the North Dakota Geological Survey published the Fourth Biennial Report which was devoted exclusively to clays and clay products. Numerous clay deposits were sampled, analysed, and heat tested for their various ceramic qualities. Quantity of clay in the deposits was not given much attention, but numerous sections were measured and described. Many analyses were listed showing an alumina content of 20% or higher.

In 1937 a report, "The Bentonites of North Dakota" by W. E. Budge, was published by the School of Mines of the University of North Dakota. This report was concerned with the Little Badlands area in Stark County and the White Butte area in Slope County. Over one hundred million tons of bentonite was measured in portions of four townships in the Little Badlands area, under light overburden. In the White Butte (or Chalky Butte) area, sixty million tons of bentonite was measured but the stripping ratio was determined as about 4 to 1. Five samples from the Little Badlands area averaged 18% alumina, and six samples from White Butte averaged 19%.

In 1948 the U. S. Bureau of Mines published Report of Investigations #4219, "Southwestern North Dakota Clay Deposits Stark, Slope and Billings Counties, North Dakota." This report concerned the Little Badlands area, the Chalky Butte area, and areas near Marmarth and Belfield. Clay deposits in these four areas were carefully evaluated as to quantity and quality by mapping and sampling. Clay deposits overlain by more than 20' of overburden were not included in either the measured or estimated tonnages and thus the estimate of clay available is about 38 million tons in the Little Badlands area - a lesser figure than given in Budge's report mentioned above. The average alumina analysis of the Little Badlands clay is about 14%.

In 1958 the Great Northern Railway Company compiled a report, "Williston Basin Clays", in which four clay deposits in North Dakota are considered. A twenty-five million ton deposit of clay with a 20 to 25% alumina analyses under an average of 40 feet of overburden is reported in T 158 N., R 93 W., sections 20, 29 and 30. At the outcrops in section 30 the bed was found to be between 22 and 31 feet thick. Three drill holes in section 29 to the east of the outcrops also reached the clay deposit.

A second deposit was located by two drill holes in section 28. This bed was considered to be a continuation of the bed located in the first deposit and its presence is inferred in sections to the north, south and east. On this basis the size of the deposit is estimated at 100 million tons. Analysis of samples from one of the test holes gave an average alumina analysis of 15.4% with overburden estimated at from 20 to 40 feet.

Two other deposits referred to in this report are the South Ross deposit, with outcrops on either rim of the valley in Townships 153 and 154 and Ranges 92 and 93. In the South Ross deposit a 15' bed is reported under more than 150 feet of overburden. The East Tloga deposit (T 157 N., R 94 W., Section 33) consists of a 10 foot bed with an alumina analysis of 15.24% under 40 feet of overburden.

The Northern Pacific Railway Company has a clay report in preparation which also is concerned with the possibility of alumina production.

Geology of North Dakota Clays

Clay deposits are widespread in almost all Cretaceous and Tertiary formations in North Dakota.

The Pierre formation in North Dakota is a massive gray shale from 900 to 2300 feet thick. The Pierre shales were deposited in shallow seas far enough off shore to be generally beyond the zone of sand deposition. Clays from the Pierre as well as the underlying Benton and Niobrara have been sampled and analyzed by the North Dakota Geological Survey (Leonard, 1906, pp. 100-107) but due to limits set in this investigation as to alumina content and overburden, they were not sampled for this report.

The Fox Hills formation, which overlies the Pierre is composed mainly of sandstones, sands, and sandy clays. In the course of this investigation no satisfactory clay beds were located in the Fox Hills formation and no samples were taken. The Cretaceous Fox Hills and Hell Creek and the Tertiary Cannonball, Ludlow and Tongue River formations are described by Laird and Mitchell (1942 pp. 4-23) in southern Morton County and only details of sampled clay deposits will be attempted here.

No clay deposits suitable for this investigation were found among the lignitic shales of the Hell Creek. The clay beds observed were found to be sandy, thinbedded and generally discontinuous. The same general description may be made of the clays in the Ludlow and Cannonball formations of the Paleocene which lie above the Hell Creek.

Most of the clay samples obtained in the course of this investigation were taken from the Tongue River (Paleocene) and the Golden Valley (Eocene) formations. These formations have been described in earlier publications of the North Dakota Geological Survey (Caldwell, 1954, and Fisher, 1954). The Tongue River formation forms the greater part of the surface of western North Dakota exclusive of the drift-covered areas.

The overlying Golden Valley formation consists of scattered exposures whose total area is less than 8 townships in extent. The youngest Tertiary formation in North Dakota is the White River (Oligocene). Some gravels of questionable age (Miocene or Pliocene) are present locally but their age has not been definitely determined. The areal extent of White River exposures is probably less than 3 townships. Little was done in this investigation on

White River clays because of the comprehensive investigation published earlier by the Bureau of Mines (Clarke, 1948). Both the Golden Valley and White River formations have been described by William E. Benson (1952 pp. 68-102).

Since the Tongue River and Golden Valley formations furnished most of the samples collected for this investigation, they will be discussed more fully below.

Tongue River Formation

The Tongue River formation in North Dakota consists of from 200 to 800 feet of buff to gray sands and soft sandstones, and gray to brown shales and shaly clays, with numerous lignite seams. Beds of pale red clinker that are a common feature of the Tongue River formation were formed when lignite seams caught fire at the outcrop and baked the overlying shales and sands. The sediments which make up the Tongue River formation were mainly stream-borne from the Rocky Mountains and the Black Hills. As might be expected these deposits are extremely lenticular lignite beds pinch out, sands grade into shales and correlations between sections only a mile apart are often tenuous.

Numerous Tongue River clays were sampled for this investigation. Chemical analysis proved most of them to be in the range of 10-15% alumina, below the figure of 20% alumina which was the minimum analysis desired if the clay were to be considered as a potential source of alumina.

Golden Valley Formation

The Golden Valley formation as described by Benson (1952), consists of two members ranging in thickness from less than 100 to about 180 feet thick. The lower member is usually 15 to 35 feet thick and consists of gray to purple gray shales and gray to white sandy kaolinitic clays. The clays are commonly stained a bright orange due to iron oxide. Locally the lower member contains a few thin lignites which are extremely discontinuous. The upper member of the Golden Valley formation consists mainly of micaceous sands with some shale and silty clays. Like those of the Tongue River, the sediments of the Golden Valley formation were washed in from the west, probably from the Rocky Mountains area.

The Golden Valley clays sampled for this report are the white clays from the lower member. A number of these clays have proved on analysis to contain 20% or more alumina, but no area has been found in which the tonnage requirements can be satisfied. The Golden Valley formation exists as a remnant of a once widespread formation which must have covered a large area of western North Dakota. The scattered Golden Valley exposures that have escaped erosion are found on ridge tops and in structurally low areas of the Tongue River formation such as the Little Badlands area of Stark County.

Field Work 1957

Field parties sampled known clay deposits from the Tongue River (Paleocene) and the Golden Valley (Eocene) formations in western North Dakota.

In sampling it was borne in mind that a 50 million ton clay deposit is represented by a bed 8' thick extending over nearly four square miles, and except for a few samples taken for quality only, no effort was made to sample deposits which obviously contained lesser amounts. Clay beds less than 8' thick were not sampled due to the fact that machine methods of mining are unsatisfactory for thinner beds. Clay beds were not sampled if overlain by excessive overburden. Overburden was considered excessive if it measured more than twice the thickness of the clay bed to be sampled.

Lignite represents no problem since it is found over a wide area of western North Dakota, but an adequate water supply is available only from the Missouri or the Souris rivers.

Limestone of the high purity required in the lime-soda sinter process is not available in North Dakota and would have to be shipped in.

Larger amounts of limestone are required in the lime-soda sinter process as the silica content of the clay increases (Conley and Skow, 1949, p. 7). With an ore containing approximately 50% alumina and 20% silica, 72 pounds of limestone would be needed for each 100 pounds of ore. When the silica content is 29% equal parts of limestone and ore are needed. On this basis far more limestone and ore are needed. On this basis far more limestone than ore would be required to treat the North Dakota clays.

North Dakota kaolinitic clays which analyze around 20% alumina and 60% silica contain a good deal of free silica which could be removed mechanically, but even if the alumina silica ratio could be raised to that of pure kaolinite, we could not expect to improve on the figure of 5 tons of limestone to 3 tons of clay (Cservenyak, 1947, p. 3) which is the figure obtained by pilot plant tests on kaolin clays from South Carolina which ran from 33% to 35% alumina.

Field Work 1958

During the 1958 seasons more samples were obtained, generally following the same plan as in 1957 except that channel samples were taken in 8' increments or fraction thereof from the base of the clay deposit and the deposit was also sampled at 2' intervals from the base. This plan was followed to facilitate matters for the chemists. If an 8' channel sample gave a low determination of alumina, the individual 2' samples were analysed. If an 8' channel sample proved to contain 20% or more alumina, it was unnecessary to run determinations on the individual 2' samples.

In 1958 in addition to sampling the known Tertiary clay deposits, the Cretaceous and Tertiary formation contacts (see North Dakota Geological Survey

Geologic Map of North Dakota, 1956) were examined for clay deposits. The clay beds associated with lignite seams were sampled in the good exposures provided by strip mine operations.

All of the clay deposits sampled in the course of this investigation are shown on the sample location map (Figure 1). The samples were collected by staff members including Dan Hansen, Sidney B. Anderson, John R. Bergstrom and the writer.

Differential Thermal Analyses

Clay types in many of the samples were determined by differential thermal analysis. The Golden Valley clays proved to contain kaolinite in percentages varying from 10 to 80%. Many of the Tongue River clays also contain kaolinite but those associated with lignite seams proved to be illite, montmorillonite or mixtures of the two, except for one sample of an underclay which indicated a 20% kaolinite content. Carbonates and dolomites masked some of the curves so that no good clay identification could be made.

Laboratory Analysis

Analysis of the clays for aluminum oxide was performed in a laboratory in the Geology building on the University of North Dakota campus. It is recognized that other elements are critical in processing clays for recovery of alumina, such as silica and iron, but since prior requirements as to available tonnages and required alumina content were never met, no further analyses were made. A discussion of the laboratory work will be found in the chemist's section in Appendix I of this report, which was prepared by Dr. R. G. Splies and Mr. D. C. Hampton.

Discussion of Selected Areas

Although no areas were found of sufficient tonnages of clay containing 20% or more alumina there are several areas which easily satisfy the tonnage requirements. Unfortunately the aluminum oxide analyses are low - from 12 to 17%. One of these is given special mention for the sole reason that in an emergency or with improved technology it might be expedient to process these clays. In Township 148 North, Range 83 West, Sections 18 and 19, five and one-half miles east of Garrison, North Dakota, just west of Highway 83, an average of 35' of overburden is removed in order to strip coal. An abundant supply of water is available from Garrison Reservoir which borders the pit on the south. The clay, which runs 12% alumina, is stripped in the process of mining the coal, thus the greater part of the cost of mining the clay could be charged against stripping. Limestone would have to be shipped in. Differential thermal analysis of this clay showed that the major clay mineral present is montmorillonite which is not encouraging since montmorillonite contains only about 20% alumina, while kaolinite contains from 37-39% alumina.

Conclusions and Recommendations

Clays in North Dakota Tertiary deposits which proved to contain 20% or more alumina are kaolinitic.

If these deposits were capable of being up-graded so that they approached the chemical content of pure kaolinite (39% alumina 46% silica) the amount of limestone required for producing alumina by the lime-soda sinter process would still exceed the amount of clay required. This limestone would have to be shipped in from outside the state. It seems unlikely that limestone quantities in excess of the clay required could be economically shipped to any point in North Dakota for the purpose of manufacturing metallurgical alumina.

The only alternative in sight is that presented by a Grand Forks group which organized to investigate underground mining of limestone. This group was interested in the limestone for cement manufacture. Since limestone is the one raw material not presently available in North Dakota the development of a source within the State could considerably lower cost estimates on alumina production.

It might be well to consider sulphuric acid extraction in the event that North Dakota clay deposits are exploited for alumina. Acid extraction of North Dakota clays has been reported as producing alumina "equivalent to or approaching metallurgical grade" (Clarke, 1948, p. 32). Acid extraction processes for preparing metallurgical alumina are rather fully explored in two publications of the Bureau of Mines (Tilley and others 1927, and Pask and Davies, 1943).

No clay deposits of a grade and size suitable for the manufacture of metallurgical alumina were found in the course of this investigation, and if further exploration is to be done for such deposits a systematic drilling program is suggested.

In Mercer County north Golden Valley and in Dunn County north of Dodge and Halliday are two large areas of outcrops of the Golden Valley formation which might be good selections for drilling. The first of these areas is within two miles of an adequate water supply from the Garrison reservoir. Another area south of Dodge is less favorably situated as to water supply. These areas of Golden Valley formation exposures are shown on the sample location map, and also on the U. S. Geological Survey quadrangles of Golden Valley, Beulah and Broncho.

APPENDIX I
CHEMICAL ANALYSIS OF CLAY FOR
ALUMINA CONTENT

by

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Introduction

The so-called classical methods of alumina analysis give accurate results; however they are tedious, time-consuming and require skilled technicians. In the course of this work it was determined that a high degree of accuracy was unnecessary. Accordingly, attempts were directed toward the development of procedures that would give results accurate within one or two percent in a reasonably short time.

The first method employed precipitating agents that would selectively tie up the majority of interfering ions leaving the aluminum in solution. The aluminum was then precipitated, dried and weighed. This method gave evidence of succeeding; however the many operational difficulties to be overcome indicated that considerable research was necessary to make the method effective and reliable.

The method next considered was the one ultimately chosen for use on this project. It consisted of a basic fusion of the clay followed by a pH titration of the resulting solution. The method proved to be reasonably rapid and capable of yielding good precision and accuracy.

Experimental

The sample of clay was dried for two hours at 140°C prior to crushing and grinding. If the sample was caked in large pieces after this preliminary drying it was run through a crusher to reduce the size of the pieces to about one-quarter inch. These smaller pieces were ground in either a ball mill or an electric coffee grinder. After grinding the sample was sized by shaking in a series of standard sieves. The sample submitted for analysis consisted of particles that passed through a 200 mesh sieve. Before weighing, the sample was dried at 140°C for at least two hours and cooled in a desiccator. A one gram sample, accurate within two milligrams was weighed directly into a 35 ml. platinum crucible. The sample was thoroughly mixed with 6.5 grams of flux. (The flux consisted of 6 grams of anhydrous sodium carbonate and 0.5 gram of anhydrous sodium tetraborate.) After covering the crucible with a platinum cover it was warmed over a low Meeker burner flame until the excessive bubbling ceased. Then the burner was increased to full heat for about fifteen minutes. At this point the cover was carefully

removed and heating continued for one-half hour. At the completion of the fusion the mixture was a clear liquid with a water-like consistency. The melt was cooled and both lid and crucible transferred to a 600 ml. beaker fitted with a watch glass cover. The melt was dissolved in a mixture of 40 ml. each of distilled water and concentrated hydrochloric acid. When solution was complete the cover and crucible were thoroughly rinsed and removed from the beaker. The solution was heated to boiling on a hot plate in the hood to remove any dissolved carbon dioxide. After cooling to room temperature in a water bath the pale yellow solution was transferred to a volumetric flask and diluted to 500 ml. From this diluted solution aliquots were taken for final titration. In general a 12.5 ml. aliquot was used; however in some of the earlier work an aliquot twice this size was used. The aliquot was diluted with 200 ml. of distilled water and 10 ml. of a potassium oxalate solution (to remove interfering calcium ions). This mixture then was stirred with a magnetic stirrer while the final titrations were carried out. The titrations were followed with a line-operated, Beckman model H pH meter. The solution was adjusted to a pH of 12 with sodium hydroxide. This converted any iron to the insoluble hydroxide. The pH was lowered carefully to a value slightly below ten. Then 40 ml. of potassium fluoride solution was added. The potassium fluoride reacted with the aluminum with the subsequent liberation of hydroxyl ions. The amount of hydroxyl ions formed was related to the aluminum originally present. The concentration of the hydroxyl ion was determined by titration with standard hydrochloric acid. From the amount of hydrochloric acid required to bring the pH of the solution to a value just below ten the original percent of alumina could be determined.

Discussion

It will be noted that this procedure was carried out without the removal of silica. Since extremely accurate results were not demanded, the time-consuming silica removal was omitted. However, according to the article by H. L. Watts in *Analytical Chemistry*, volume 30, page 967, 1958, increased accuracy could be expected if the silica were removed as the volatile fluoride prior to the alumina analysis.

It was found that particle size was important in the analytical scheme. Insufficient grinding resulted in lumps of material that were extremely resistant to fusion. Incomplete fusion yielded low values on analysis. It was found that sample sizes of -200 mesh could be obtained by grinding either in a ball mill or in an electric coffee grinder. The action of the coffee grinder was much more rapid and clean-up time between samples was less so the majority of the samples were prepared by passage through the coffee grinder.

After fusion, when the melt had been dissolved in the hydrochloric acid, it was essential to remove the platinum ware and dilute the solution immediately. If the solution were allowed to stand for any length of time before dilution silicic acid would precipitate from solution. The presence of this gel made quantitative transfers difficult and in addition tended to plug the tips of the burettes and pipettes.

During the course of the analyses it was noted that suddenly the results became consistently low. This trouble was finally traced to an improperly functioning glass electrode. Until a new electrode could be placed into service this malfunction was corrected by arbitrarily adding to the determined values a factor of 3.3 (the difference between the National Bureau of Standards value and the experimentally determined value).

It should be noted that any weight of clay could be used for analysis. However, the method was changed in that all samples analyzed during the course of this work were of the same original weight. Since the final volume of liquid titrated was dependent on the original weight a constant starting weight eliminated many calculations and any chance of confusion. In addition the use of equal weights of clay made the final calculation of alumina percent more rapid with less chance of mathematical error. Finally, it should be pointed out that the above discussion is not intended to be a thorough treatment of the theory and chemistry involved in the alumina analytical scheme employed in this work. If a more comprehensive treatment is desired the aforementioned article by H. L. Watts is recommended as an excellent source of material.

Appendix II

List of Sample Locations and Analyses

Sample locations are listed by township, range, and section in the first column of the table below. For example, the first sample number on the list at the head of the table is shown as 130-104-12. Referring to the sample location map (Figure 1) a circled dot is found in Township 130, Range 104, Section-12 indicating the location of the sample.

Township	Range	Section	Sample No.	Analysis
130	104	12	130-104-12	...
130	104	13	130-104-13	...
130	104	14	130-104-14	...
130	104	15	130-104-15	...
130	104	16	130-104-16	...
130	104	17	130-104-17	...
130	104	18	130-104-18	...
130	104	19	130-104-19	...
130	104	20	130-104-20	...
130	104	21	130-104-21	...
130	104	22	130-104-22	...
130	104	23	130-104-23	...
130	104	24	130-104-24	...
130	104	25	130-104-25	...
130	104	26	130-104-26	...
130	104	27	130-104-27	...
130	104	28	130-104-28	...
130	104	29	130-104-29	...
130	104	30	130-104-30	...

Locality and Sample No.	Total Thickness	No. of Samples	Range of Al ₂ O ₃ anal %	Av. anal Al ₂ O ₃ %
130-104-12	15'	2	14.1-15.2	14.6
133-81-13	24'	3	10.4-11.1	10.6
134-89-33	24'	3	15.7-18.8	17.0
136-97-13	10'	1	16.3	--
136-102-2	14'	3	11.9-15.8	13.8
136-102-19	9'	1	13.5	--
138-96-36	25'	6	10.0-14.3	12.2
138-102-11	24'	1	14.4	--
138-102-14	32'	1	13.2	--
139-93-32	13'	2	19.6-23.4	21.5
139-96-8	12'	2	18.1-19.0	18.5
140-90-6	3'	24	16.8-23.2	18.9
140-90-11	30'	4	5.9- 7.9	6.5
140-93-29	11'	1	16.9	--
140-94-33	11'	2	9.1-21.9	15.5
140-95-32	9'	2	16.4-20.4	18.4
141-89-33	17'	2	14.9-20.6	17.7
141-95-4	10'	2	15.1-16.4	15.7
141-96-25	24'	3	11.0-15.0	13.3

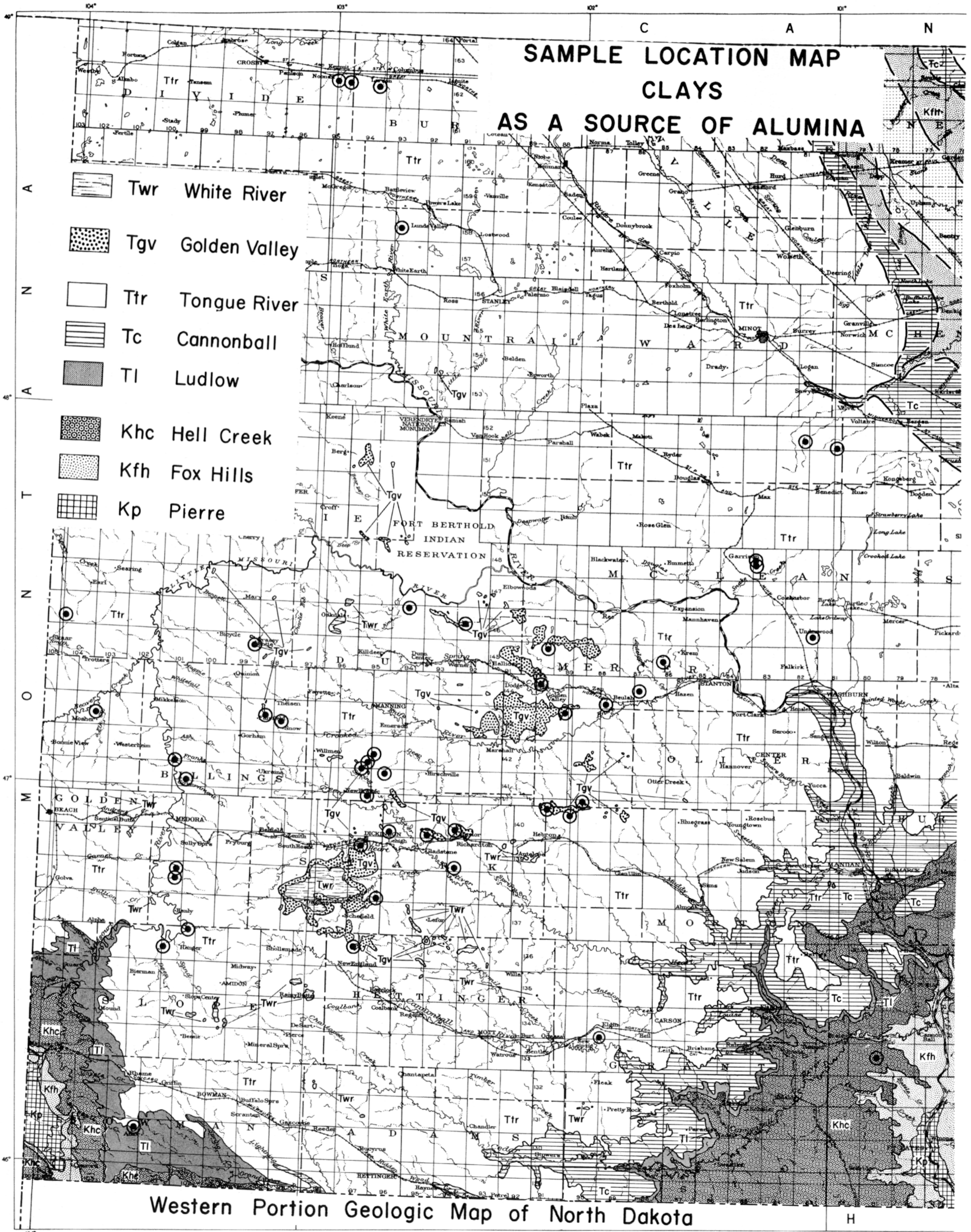
Locality and Sample No.	Total Thickness	No. of Samples	Range of Al_2O_3 anal %	Av. anal Al_2O_3 %
141-101-21	34'	1	13.0	--
142-95-19	10'	2	15.0-16.0	15.5
142-96-25	5'	1	14.8	--
142-96-35	40'	5	10.0-20.0	15.4
142-101-31	15'	1	13.1	--
143-90-2	12'	2	19.3-19.4	19.3
143-98-20	21'	4	10.2-21.4	16.9
143-99-14	25'	6	13.2-22.1	15.6
143-104-22	8'	1	14.6	--
144-87-17	30'	4	11.2-12.0	11.6
144-88-29	10'	1	14.4	--
144-90-8	18'	4	12.9-23.7	17.7
145-86-21	16'	2	12.8-15.2	14.0
145-90-11	24'	5	18.1-22.6	22.0
145-99-13	9'	3	18.7-25.3	22.3
146-82-23	10'	1	17.4	--
146-92-17	30'	4	10.8-16.4	14.0
146-94-4	14'	3	5.5-14.8	9.6

Locality and Sample No.	Total Thickness	No. of Samples	Range of Al ₂ O ₃ anal %	Av. Anal Al ₂ O ₃ %
146-104-29	23'	1	17.6	--
148-83-18 & 19	18'	2	15.2-16.4	15.8
152-81-35	grab sample		11.8	
152-82-25	" "		16.2	
162-94-14	" "		16.8	
162-95-10	24'	3	7.6-11.5	9.9
162-95-12	12'	1	12.0	--

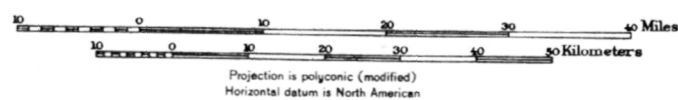
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SAMPLE LOCATION MAP CLAYS AS A SOURCE OF ALUMINA



Western Portion Geologic Map of North Dakota



Projection is polyconic (modified)
Horizontal datum is North American