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BENTONITE AND BLEACHING CLAY IN JAPAN

GENERAL HEADQUARTERS
SUPREME COMMANDER FOR THE ALLIED POWERS
NATURAL RESOURCES SECTION
REPORT NO 139
TOKYO 1951

REPORT NUMBER 139

January 1951

BENTONITE AND BLEACHING CLAY IN JAPAN

by

Donald E. Lee

GENERAL HEADQUARTERS
SUPREME COMMANDER FOR THE ALLIED POWERS
Natural Resources Section

NATURAL RESOURCES SECTION
REPORT NUMBER 139
January 1951

BENTONITE AND BLEACHING CLAY IN JAPAN

TABLE OF CONTENTS

	Page
Summary	4
Introduction	4
1. Terminology and Scope of Report	4
2. Sources of Information and Acknowledgments	5
Bentonite	6
1. Historical and General	6
2. Production and Consumption	6
3. Domestic Producing Areas	7
4. Geologic Features	7
5. Mining Methods	9
6. Costs of Production	10
7. Processing and Grading Methods	11
8. Reserves and Future Supply	12
9. Individual Producing Areas	12
a. Southwestern Gumma Prefecture	12
b. Northern Nagano Prefecture	14
c. North Central Niigata Prefecture	14
d. Central Yamagata Prefecture	17
e. Hokkaido	18
f. Other Mines	18
Bleaching Clay	19
1. Historical and General	19
2. Production and Consumption	19
3. Domestic Producing Areas	20
4. Geology and Mining	20
5. Costs of Production	20
6. Processing Plants	22
7. Processing Methods	22
8. Reserves and Future Supply	23
9. Individual Producing Areas	23
a. Niigata Prefecture	23
b. Yamagata Prefecture	25
c. Fukushima Prefecture	25
Selected Bibliography	26
Glossary	
1. Conversion Factors	26
2. Japanese Terms	26
Figures	
1. Major Bentonite Producing Districts	8
2. Drying Bentonite	11
3. Bentonite Mines and Processing Plants, Usui-gun, Gumma Prefecture, 1949	13
4. Bentonite Mines and Processing Plants, Higashi-Kambara-gun, Niigata Prefecture, 1949	15

TABLE OF CONTENTS (CONT'D)

Page

Figures (Cont'd)
5. Bentonite Mines and Processing Plants, Minami-Murayama-gun, Yamagata Prefecture, 1949 16
6. Bleaching Clay Mines and Processing Plants. 21
7. Bleaching Clay Mines and Processing Plants in Northern Niigata Prefecture, 1949. 22
8. Flowsheet of Process Used for Activating Clay at Mizusawa Plant, Yamagata Prefecture. 23
9. Idealized Cross-Section of Niigata Bleaching Clay Deposits. 24

Text Tables
A. Production of Bentonite, 1938-49. 6
B. Production of Bentonite by Various Producing Areas, 1949. 6
C. Costs of Finished Bentonite Production, Selected Years, 1938-49 10
D. Costs of 150-Mesh Bentonite Production, 1947. 10
E. Classification Standards of Teikoku Bentonite Kogyo KK, 1948. 11
F. Representative Analyses of Bentonite from Wakamatsu and Horikappu Mines, Hokkaido. 18
G. Production of Bleaching Clay, 1935-49 19
H. Japanese Exports of Bleaching Clay, 1935-44 20
I. Costs of Production of Naturally Adsorptive and Activated Clays, 1949 20
J. Representative Analyses of Naturally Adsorptive Clays from Odo Mine, Niigata Prefecture. 24

Appended Tables
1. Locations of Bentonite Mines and Processing Plants in Northern Nagano Prefecture, 1949 27
2. Locations of Principal Bleaching Clay Processing Plants, 1949 27
3. Capacities and Past Production of Principal Bleaching Clay Plants, 1949 . . . 27
4. Locations of Bleaching Clay Mines in Niigata Prefecture, 1949 28
5. Production of Naturally Adsorptive and Activable Clays by Mines in Niigata Prefecture. 28
6. Locations of Bleaching Clay Mines in Yamagata Prefecture, 1949. 28
7. Production of Naturally Adsorptive and Activable Clays by Mines in Yamagata Prefecture. 28

List of Natural Resources Section Reports and Preliminary Studies
Distribution

NATURAL RESOURCES SECTION
REPORT NUMBER 139
January 1951

BENTONITE AND BLEACHING CLAY IN JAPAN

by
Donald E. Lee 1/

SUMMARY

1. Bentonite was first recognized as such in Japan about 1930, but production was small until 1938. During 1938-49 production averaged about 34,000 tons annually. Present annual production is 40,000 tons.

2. Bleaching clays are known to have been produced in Japan since about 1890. Production was less than 3,000 tons annually until 1915 but reached 15,000 tons in 1935 and averaged about 34,000 annually during 1935-45. During 1946-49 the average annual production was 4,000 tons.

3. Bentonite is used principally as a fertiliser (night soil) carrier, in the manufacture of soaps, cosmetics, and medicines, for rotary drilling mud, and as a foundry sand bond. Bleaching clays are used domestically to refine petroleum and animal and vegetable oils.

4. Neither bentonite nor bleaching clay ever has been imported, but both have been exported. In 1943, 3,000 tons of bentonite were shipped to the Netherlands East Indies for use in oil well drilling operations. Exports of bleaching clay exceeded 48,000 tons during 1935-44; importing countries were China, Korea, the Philippines, and the Netherlands East Indies.

5. Commercial deposits of bentonite and bleaching clay are found only in northern Honshu and Hokkaido. Nearly all of these deposits are derived from liparites and liparitic tuffs of early Miocene age that were deposited in the early stages of the development of the Japan Sea geosyncline. Geologists disagree concerning the exact type of alteration which took place, but the montmorillonite minerals probably are authigenic.

6. Mining is by simple underground or open pit methods. Most labor is supplied by local farmers. Processing methods also are simple and in no way comparable to methods practiced in the United States.

7. Neither the bentonite nor the bleaching clay reserves of Japan ever have been surveyed systematically, but reserves of both are known to be large enough to supply any conceivable demand in the foreseeable future. A producers' estimate, probably little more than a guess, places bentonite reserves in excess of one-half billion tons. Probably bleaching clay reserves are of the order of millions of tons.

INTRODUCTION

1. Terminology and Scope of Report

Bentonite is a clay which has been formed through the devitrification and chemical alteration of glassy igneous material, principally volcanic ash or tuff. Bentonites are

1/ Scientific consultant, Mining and Geology Division.

composed mainly of the clay mineral montmorillonite, $(OH)_4Al_4Si_8O_{10}xH_2O$. The physical properties of bentonite are widely variable, but two main types, with intermediate gradations, are generally recognized. The first of these types absorbs much water, has strong swelling properties, develops a high plasticity, and contains a large amount of material which remains in suspension in thin water dispersions. The second type, comprising the majority of the bentonites, absorbs no more water than ordinary plastic clays, swells only slightly, and crumbles in water.

In the United States about 85 percent of the bentonite produced is used either as a foundry sand bond or as a base for oil-well drilling muds. The remaining 15 percent has a variety of minor uses. In Japan bentonite is used as fertilizer carrier, for the manufacture of soap and cosmetics, as rotary drilling mud, and for a variety of other purposes. Details of utilization of Japan's production are discussed later in this report. Almost all bleaching clays are bentonitic. Bentonite which is an effective bleaching clay may be produced and sold either as bleaching clay or bentonite, depending on the intended commercial application.

The term "bleaching clay" refers to those clays which have a high adsorbent power for many substances and which therefore are used for bleaching and decolorizing oils and other liquids. The nomenclature of the bleaching clays is not yet well standardized, but two main classes are generally recognized, (1) those clays which are naturally active and (2) those which are active after treatment with acid. However, a clear distinction between these two types is not always possible, as some naturally active clays can be made more active through acid treatment. This report will refer to the two types of bleaching clays as "naturally adsorptive" clays and "activable" clays. Generally the activable clays, after acid treatment, are more efficient bleaching agents than the naturally adsorptive clays.

Some bleaching clays are known as "fuller's earth". The term "fuller's earth" has been in a state of flux for years, and its usage generally has responded to changing commercial standards. However, it gradually has come to denote those clays which have an appreciable natural adsorptivity, more especially clays of this type which occur in southeastern United States.

In the United States some bauxite is activated by heat treatment and used in petroleum refining. However, Japan has no bauxite reserves, and no further mention of activated bauxite will be made in this report.

This report on Japan's production and resources of bentonite and bleaching clay is the third and final publication in a series of Natural Resources Section reports on the various types of clay found in Japan. The previously published reports in this series are Fire Clay Resources of Japan and Whiteware Raw Material Resources of Japan. 2/

2. Sources of Information and Acknowledgments

The information contained in this report was drawn from many sources. Cost and production data were obtained from producers through personal interviews and questionnaires, and sources are acknowledged in the text. Because much of the output is by small producers, some operating only seasonally and many supplying only local industries, few data are available from centralized sources such as government agencies. Data on geology and reserves are especially difficult to obtain.

Dr T. Sudo of Tokyo University and Dr S. Iwao and Mr K. Kanehara of the Japanese Geological Survey provided helpful information on geology of various deposits. Information on the mineralogy of the bentonite deposits was obtained through personal correspondence with Dr R. E. Grim, head of the Division of Clay Resources and Clay Mineral Technology,

2/ Lee, Donald E., Fire Clay Resources of Japan: Natural Resources Section Report No 130, Tokyo, Jul 1950. Lee, Donald E. and Hasegawa, Hideshiro, Whiteware Raw Material Resources of Japan: Natural Resources Section Report No 135, Tokyo, Oct 1950.

Illinois State Geological Survey. Free use was made of unpublished field notes, taken by Mr P. O. Elmquist of the United States Geological Survey in 1947, while a member of Mining and Geology Division.

Dr B. M. Page and Mr Leo W. Stach, scientific consultants, Mining and Geology Division, read the manuscript and offered many constructive criticisms.

BENTONITE

1. Historical and General

Bentonite from the Numata area of Gumma Prefecture is known to have been used in minor quantities for the manufacture of soap for about 50 years. Other bentonite deposits throughout northern Honshu probably have been worked for similar purposes for many years. However, bentonite was not recognized as such in Japan until about 1930, and no appreciable production materialized until 1938.

2. Production and Consumption

Japanese production of bentonite during 1938-49 averaged about 34,000 tons annually, reaching its highest level in 1942-43 (Table A). These figures are estimates with a probable error of ± 20 percent, especially for the years before 1945. Production has again been increasing in recent years and was estimated at 40,000 tons in 1949.

TABLE A. - PRODUCTION OF BENTONITE, 1938-49
(metric tons)

Year	Production	Year	Production
1938	12,000	1945	30,000
1939	20,000	1946	30,000
1940	25,000	1947	35,000
1941	35,000	1948	35,000
1942	45,000	1949	40,000
1943	60,000		
1944	40.000	TOTAL	407,000

SOURCE: Estimates by Nihon Bentonite Shokogyo Kyodo Kumiai (Japan Bentonite Commercial and Industrial Assn)

The relative importance of the various producing areas in 1949 is summarized in Table B. Available detailed production data are given in the discussion of individual mines and areas later in this report. In many instances these data are incomplete or unreliable.

TABLE B. - PRODUCTION OF BENTONITE BY VARIOUS PRODUCING AREAS, 1949

Producing Area	Production (MT)	Percent of Total	Year of First Production
Southwestern Gumma Prefecture	16,000	40.0	1940
Northern Nagano Prefecture	2,000	5.0	1938
North central Niigata Prefecture	12,000	30.0	1930
Central Yamagata Prefecture	4,000	10.0	1940
Hokkaido	5,000	12.5	1940
All others	1,000	2.5	NA
TOTAL	40,000	100.0	NA

NA: Not applicable
SOURCE: Estimates based on information submitted by individual mines and Nihon Bentonite Shokogyo Kyodo Kumiai.

The major markets for Japan's bentonite production in 1949 were approximately as follows: fertilizer (night soil) carrier, 40 percent; soap, cosmetic, and medicinal manufacture, 25 percent; rotary drilling mud, 15 percent; foundry sand bond, 10 percent; raw material in ceramic manufacture or binder in the manufacture of coal briquettes, 10 percent. At present experiments are under way to determine the usability of bentonite for various constructional purposes in Japan, especially as an ingredient in plaster manufacture.

Japan never has imported bentonite, domestic production having been sufficient and of adequate quality to meet all demands which have as yet developed for bentonite in Japan. Minor quantities have been exported, notably in 1943 when 3,000 tons 3/ were shipped to the East Indies for use in oil well drilling operations.

3. Domestic Producing Areas

Almost all of Japan's bentonite production has come from mines in north central Honshu and in Hokkaido (Figure 1). As discussed in the section on geologic features, the absence of producing mines in other parts of Japan can be explained largely by a consideration of its general geology. Within the geologically promising areas, the localization of producing mines within north central Honshu and Hokkaido has resulted from a number of factors such as proximity to oil well drilling operations (Niigata, Yamagata, and Akita prefectures), workability of the deposits (Gumma Prefecture), accessibility of transportation, and early discovery and exploitation which enabled certain deposits to establish a reputation among consumers.

For ease of treatment in the detailed sections in this report the producing mines are grouped from south to north as follows:

a. Southwestern Gumma Prefecture

b. Northern Nagano Prefecture

c. North Central Niigata Prefecture

d. Central Yamagata Prefecture

e. Hokkaido Prefecture

f. All others

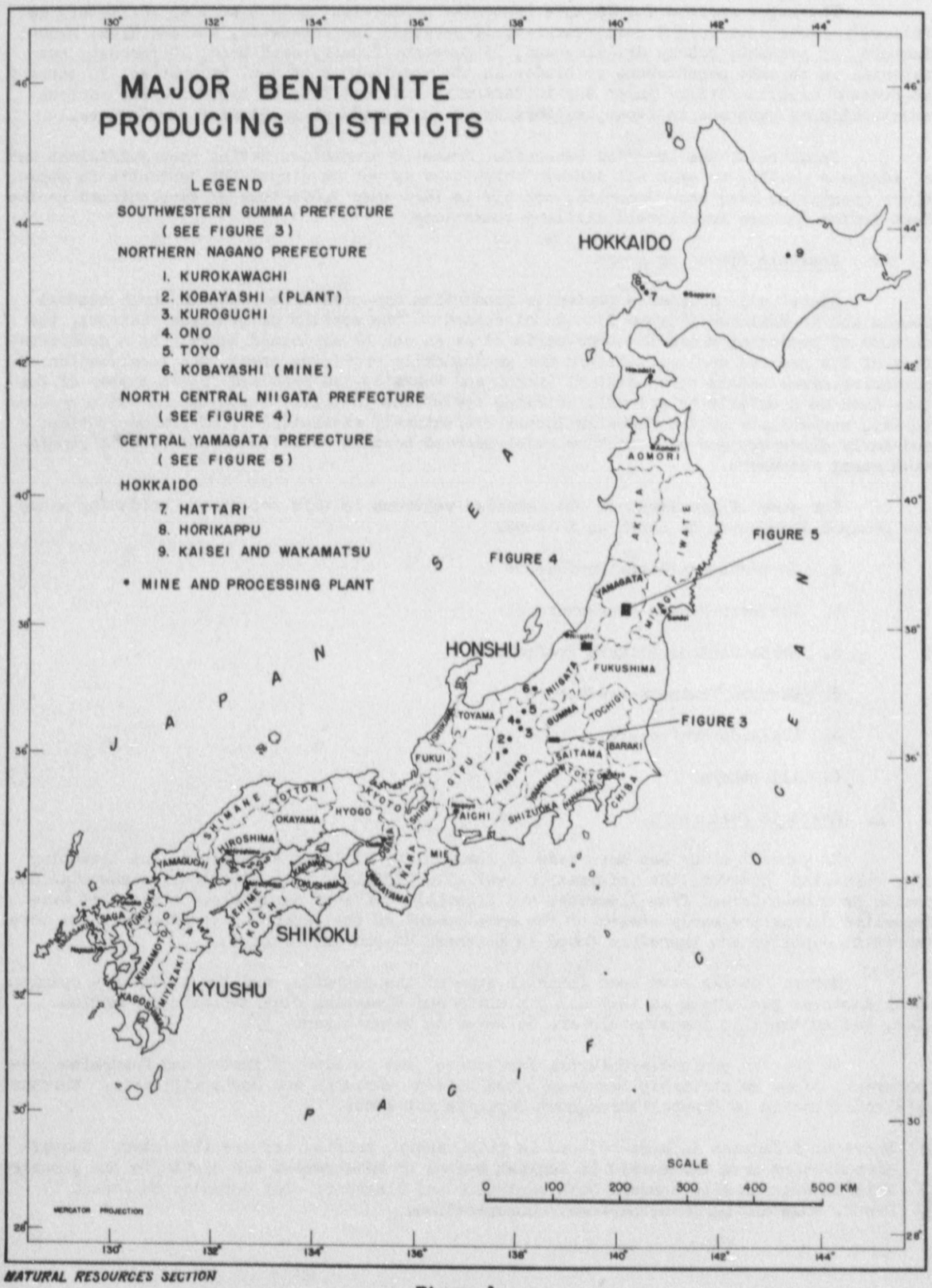
4. Geologic Features 4/

No general study has been made of the geology of Japan's bentonite and bleaching clay deposits. However, the information available indicates that almost all commercial deposits have been formed from liparites and liparitic tuffs of early Miocene age that were deposited during the early stages of the development of the Japan Sea geosyncline; the more important deposits are therefore found in northern Honshu and Hokkaido.

Marine fossils have been found in some of the deposits, and the prevailing opinion among Japanese geologists is that all bentonite and bleaching clay deposits are marine. Also, the montmorillonite minerals are believed to be authigenic 5/.

On the Izu peninsula, Shizuoka Prefecture, and in Nara, Niigata, and Fukushima prefectures a close relationship has been noted between sericite and montmorillonite. Whether this relationship is general throughout Japan is not known.

3/ Wherever reference is made to tons in this report, metric tons are indicated. Conversion factors from the metric to English system of measurement are listed in the glossary.
4/ This discussion will concern both bentonite and bleaching clay deposits in Japan.
5/ Drs T. Sudo and S. Iwao, personal communications.



NATURAL RESOURCES SECTION

Figure 1

Because of their swelling and lubrication qualities when wet, some of the bentonites, notably those along the valley of the Itoigawa 6/ in Niigata Prefecture, are the cause of numerous creeps and landslides. Occasionally, during heavy rains, the landslides cause extensive damage to roads and railroads in the area.

On the basis of available information, geologists have advanced three tentative hypotheses (with variations of each) to explain the origin of Japanese bentonite and bleaching clay deposits. These hypotheses are:

(a) The liparites and liparitic tuffs were extruded by submarine eruptions. Alteration to bentonite was accomplished by the action of the sea water and by a "shallow hydrothermal effect" resulting from large quantities of gases and vapors associated with some of the extrusives. 7/

(b) The bentonite resulted from tuff which was deposited in shallow seas and altered by the action of the sea water. 8/ This would mean the Japanese bentonites are similar in origin to those of the United States.

(c) The alteration of the tuff to bentonite was hydrothermal. After the tuffs were deposited, a later stage in the same volcanic cycle caused cracks and fractures; hydrothermal solutions then rose along these zones of weakness until a (tuff) bed was reached which would permit lateral movement. The solutions, moving along this bed, changed the tuff to bentonite or made it susceptible to alteration to bentonite by surface agencies. 9/ This theory also would explain deposits which have a larger vertical than horizontal extent and which exist in areas of recent hot spring activity.

Information available at present is not sufficient to indicate which, if any, of these hypotheses is the most nearly correct. In the future each may prove to be true in the case of given deposits. Any of these hypotheses would allow for later action by surface agencies to change the bentonite to bleaching clay.

5. Mining Methods

Both surface and underground mining methods are employed. The surface methods consist of little more than the scraping off of the overburden with hoes and the selective digging of the bentonite by hand, using explosives as needed. In northern Honshu and Hokkaido, where surface mining methods are used almost exclusively, mining is stopped for about four months during the winter because of heavy snows.

The underground methods used can be described as two types of gopher-holing. In the first method the bentonite is produced through hillside adits. In the second method short shafts, no more than 150 feet deep, are sunk to more or less horizontal bentonite beds beneath the surface; the bentonite is raised through a single-compartment shaft, the hoist being driven by an electric motor. The latter method is confined largely to the eastern Gumma Prefecture area.

All of the producing areas depend to some extent upon local farmers for a labor supply; at many of the smaller mines most or all of the labor is supplied by farmers in the area. Transportation in the mine area is usually by horse-cart or aerial tramway, occasionally by truck. More detailed information on mining methods is included in the discussion of individual mines and areas.

6/ See glossary for translation of Japanese generic terms used in this report.
7/ Dr S. Iwao, personal communication.
8/ Prof J. Takahashi, Tohoku University, according to personal communication from Prof T. Sudo.
9/ Prof T. Sudo, personal communication.

6. Costs of Production

Costs of finished bentonite production for selected years from 1938-49 are summarized in Table C. A breakdown of the costs of mining and processing bentonite of 150-mesh size in 1947, compiled from returns of questionnaires submitted to various bentonite mines and processing plants, is shown in Table D. This is the most representative cost breakdown available for any one year. The low cost of mine labor and the proportionately high cost of drying are notable.

TABLE C. - COSTS OF FINISHED BENTONITE PRODUCTION, SELECTED YEARS, 1938-49

Year	Costs of Production (yen per MT)		Approximate Conversion Rate (yen per dollar)
	150-Mesh a/	250-300-Mesh a/ b/	
1938	80	120	3.51
1941	130	200	4.27
1943	180	270	4.27
1946	1,200	1,620	15.00
1947	2,830 c/	5,250	50.00
1948	5,250	9,650	270.00
1949	5,000	7,500	360.00

a/ See section on processing and grading methods.
b/ Absorbs more than five times its weight in water
c/ See Table D for cost breakdown.
SOURCE: Nihon Bentonite Shokogyo Kyodo Kumiai

TABLE D. - COSTS OF 150-MESH BENTONITE PRODUCTION, 1947

Item	Costs (yen per ton)	Percent of Mining Cost	Percent of Processing Cost	Percent of Total Production Cost
Mining				
Labor	125	10.2	NA	4.4
Materials	130	10.6	NA	4.6
Transportation in mine area	30	2.4	NA	1.1
Office	50	4.1	NA	1.8
Preliminary drying a/	830	67.3	NA	29.3
Miscellaneous b/	66	5.4	NA	2.3
Total	1,231	100.0	NA	43.5
Processing				
Coarse crushing a/	140	NA	8.8	4.9
Fine grinding a/	354	NA	22.1	12.5
Drying a/	970	NA	60.7	34.3
Transportation in mill area	45	NA	2.8	1.6
Miscellaneous b/	90	NA	5.6	3.2
Total	1,599	NA	100.0	56.5
TOTAL	2,830	NA	NA	100.0

a/ Includes labor and materials
b/ Includes taxes, insurance, welfare funds, and depreciation.
NA: Not applicable
SOURCE: Compiled from data from individual mines and plants

Figure 2. - Drying bentonite, Matsuida-machi, Gumma Prefecture, October 1948

7. Processing and Grading Methods

Processing methods vary widely with the size of the producer and, of course, with the use to which the bentonite is to be put. At many of the smaller mines the processing consists simply of breaking the bentonite by hand methods, drying it in the sun, and crushing it by edge runners or stamp mills. Most bentonite prepared in this manner is used as a fertilizer filler.

Solar drying is often important to the larger producers also, being the first step in the milling process after initial breaking by hand methods. For this type of drying the broken bentonite is laid out on "tatami" (straw mats) (Figure 2) or on wooden racks for several days. Mill operators reported that during the summer this treatment will reduce the water content of the bentonite to about 12 percent from the 25-60 percent it contains when mined.

The final drying reduces the moisture content of the bentonite to about five percent. It is done either in rotary kilns or on large metal plates. In the latter method the bentonite is stirred continuously by human or mechanical means. After final breaking in a fret mill or a hammer mill the bentonite is classified by air suction.

The Teikoku Bentonite Kogyo Kabushiki Kaisha (KK), which has mines in north central Niigata Prefecture, is one of the largest bentonite producers in Japan. The grading system practiced by this company is summarized in Table E. The information was compiled from an advertising circular. Probably these standards are comparable to those of other large producers in Japan.

TABLE E. - CLASSIFICATION STANDARDS OF TEIKOKU BENTONITE KOGYO KK, 1948

Class	Mesh Size	Swelling Value a/	Suspension Value b/ (percent)	pH Value	Water Content (percent)
A	400	7.4	88	8.0	5
B	350	7.2	86	8.2	5
C	300	7.0	84	8.2	5
D	250	6.8	81	8.2	6
E	200	6.5	78	8.3	6

a/ The number of times its weight in water which a bentonite sample will absorb

b/ In this test dry bentonite is dispersed in a water sample 60 times the weight of the bentonite; the suspension value is the percent of the bentonite sample which remains in suspension after a given period of time. (The length of this "given" period of time is not specified.)

SOURCE: Teikoku Bentonite Kogyo KK

8. Reserves and Future Supply

Japan's bentonite reserves are estimated by producers to exceed 500,000,000 tons. Although this figure probably is little more than a guess, it indicates that reserves are large enough to supply any conceivable demand for years to come.

9. Individual Producing Areas

a. Southwestern Gumma Prefecture

Location and Accessibility: The 14 bentonite mines and eight bentonite processing factories in Usui-gun, Gumma Prefecture, are located in the area bounded by AMS coordinates 1363-1381 and 1497-1501. They are on AMS L571 (Central Japan), scale 1:250,000, Sheet 20 (Nagano), and on AMS L774 (Central Honshu), scale 1:50,000, Sheets 5855-I (Tomioka) and 5855-IV (Miyota). All mines and plants are located within six kilometers of the Shinetsu Main Line (Figure 3). Transportation to the railroad is by truck and horse-cart.

History and Ownership: Bentonite was first produced in this area about 1940. The number of operating companies increased rapidly during 1941-42 to a total of 38 in 1943, but mining activities in the area declined during 1945-46. In 1949, 16 companies were operating 14 mines and eight mills. Companies and mine and mill locations are indicated in Figure 3.

Geology and Mining: No detailed study has been made of the geology of this area; no maps are available. However, the bentonite is known to be altered liparitic tuff of Miocene age. The occurrence of hot springs in the area suggests that the alteration has been hydrothermal. Thin seams of lignite occur above the bentonite but are nowhere in contact with it.

Apparently the bentonite "zone" is about 25 kilometers long (east-west) and about two kilometers wide. The "zone" is about two meters thick in the eastern part, becoming progressively thicker to the west where one vertical shaft has encountered a thickness of 13 meters.

A sample from the Hojun Kogyo KK mine was determined by Dr R.E. Grim of the Illinois State Geological Survey to be composed of montmorillonite and about 30 percent of associated unaltered ash or cristobalite. The montmorillonite appears to have calcium as the exchangeable base.

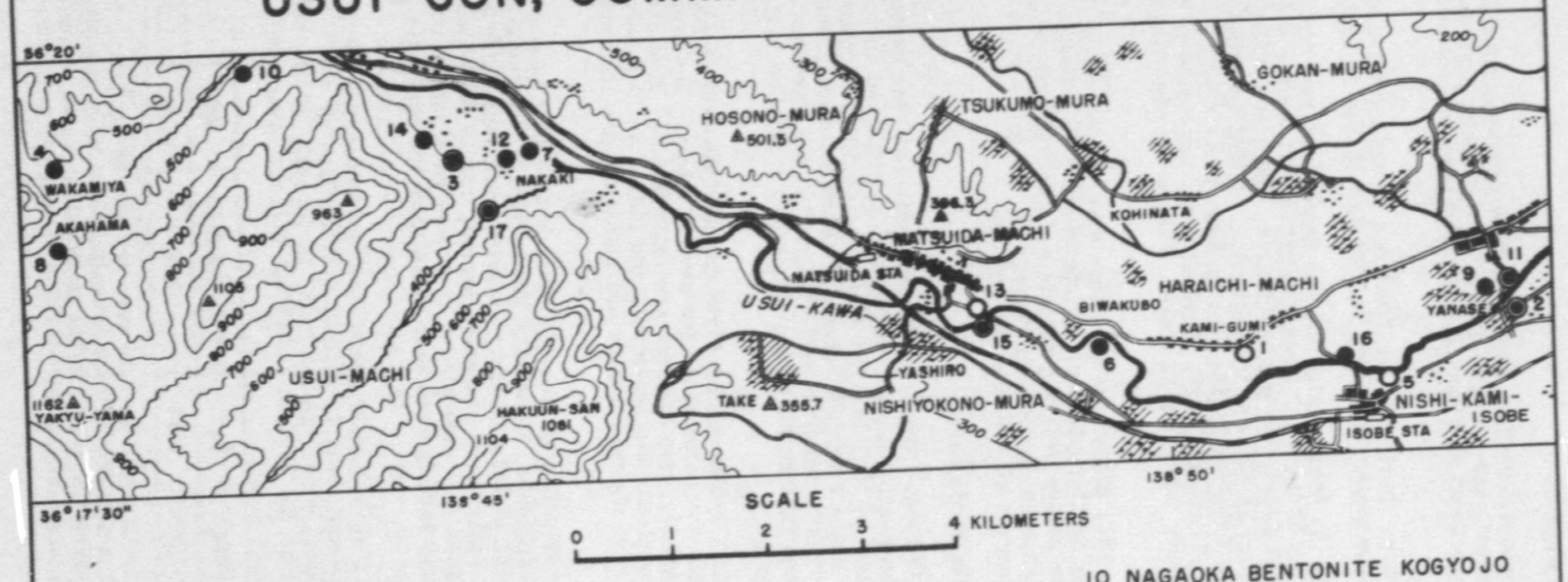
Bentonite mining in this area is entirely by gopher-holing. The bentonite is 10-50 meters below the surface and is reached by vertical or inclined shafts. The Usui Bentonite Kogyojo mine, largest in the area, has a vertical shaft about 48 meters deep and five drifts totaling about 100 meters in length. Only a small amount of timbering is necessary. The bentonite is broken by hand methods and transported to the shaft in ore cars. Hoisting is by an electric motor through a single-compartment shaft.

Production: In 1943 bentonite output from this important producing area probably exceeded 2,000 tons per month. Thereafter the production gradually declined to 500-600 tons per month during 1947, rising again to 1,300-1,400 tons per month in 1949. The estimated total output of 16,000 tons in 1949 was about 40 percent of Japan's bentonite production. No data are available on individual mine productions, but the mine of Usui Bentonite Kogyojo is known to be the largest and most important in the area.

During 1941-45 most of the bentonite was sent to Osaka for processing, but since 1945 it has been processed in the area of the mines. Some of the mines have their own preparation plants; some plants are independently owned and treat the production of several mines. Bentonite from this area is used for the manufacture of cosmetics, medicinals, and soap, as a fertiliser carrier, and as a binder in the manufacture of coal briquettes.

No data are available on the number of people employed in bentonite mining and processing in this area. Workable reserves are said to be millions of tons, but these estimates have not been determined systematically.

BENTONITE MINES AND PROCESSING PLANTS, USUI-GUN, GUMMA PREFECTURE, 1949



1 DAIDO KAGAKU K K
2 HARUNA KAGAKU K K
3 HOJUN KOGYO K K
4 IRIYAMA BENTONITE
5 ISOBE SEIFUNJO K K
6 KAMIGE KAIHATSU K K
7 KASUGA
8 KOA SHOJI K K
9 MORITA KOGYOJO K K
10 NAGAOKA BENTONITE KOGYOJO
11 NISHITOMI KOGYO K K
12 SHIRAISHI KOGYO K K
13 TAIYO KOGYO K K
14 TAIYO KOGYO K K
15 TAKARA KAGAKU SAIKUTSU K K
16 TERANISHI KOGYOJO
17 USUI BENTONITE KOGYOJO

LEGEND

- RAILWAY
- HAMLET
- MINE AND PLANT
- MINE ONLY
- PLANT ONLY
- -800- ELEVATION (METERS)

Figure 3

b. Northern Nagano Prefecture

Location and Accessibility: Four mines and five processing plants are located in northern Nagano Prefecture, and one mine in southern Niigata Prefecture is part of the same group. Locations are shown in Figure 1, and locations and accessibilities are summarized in Table 1.

History and Ownership: Bentonite was first dug in this area about 1938. The owners of the mines and processing plants operating in 1949 are listed in Table 1.

Geology and Mining: M. Uchida (Bibl 11) has determined that the bentonite deposits of this area occur in the Miocene (?) Ogawa liparitic tuff series near its contact with later Tertiary liparitic intrusives and extrusives. Both hydrothermal alteration and surface weathering have acted to form the bentonite. Where hydrothermal solutions have been predominant, usually along faults, the bentonite has a yellowish hue, said to be largely due to the action of carbonic acid. Generally the bentonite is white. The commercial bentonite bodies are very irregular in shape. They are worked by gopher-holing. Only hand methods are used.

Production: During 1949 production from this area totaled about 2,000 tons, most of which was produced during April-September. All production is processed by factories in the area. It is used for rotary drilling mud, as a fertilizer carrier, and in the manufacture of cosmetics. The labor is supplied by farmers in the area; no data are available on the number employed. Reserves of the area are unknown.

c. North Central Niigata Prefecture

Location and Accessibility: The 11 bentonite mines and five bentonite processing factories in Higashi-Kambara-gun, Niigata Prefecture, are located in the area bounded by AMS coordinates 647-661 and 1663-1673, at altitudes of 50-250 meters. They are on AMS L571 (Central Japan), scale 1:250,000, Sheet 15 (Numasawa-Numa), and on AMS L773 (Northern Honshu), scale 1:50,000, Sheet 5960-II (Tsugawa). All mines and plants are located within 10 kilometers of the Banetsu West Line (Figure 4). Transportation to the railroad is by truck and horse-cart.

History and Ownership: Bentonite was first dug in this area about 1930. However, significant production did not materialize for several years. The production has come from many small mines. Frequently, new workings are begun and old ones abandoned. The number of mines and processing plants has declined since 1943. In 1949 seven companies were operating 11 mines and five plants. Owners and locations are indicated in Figure 4.

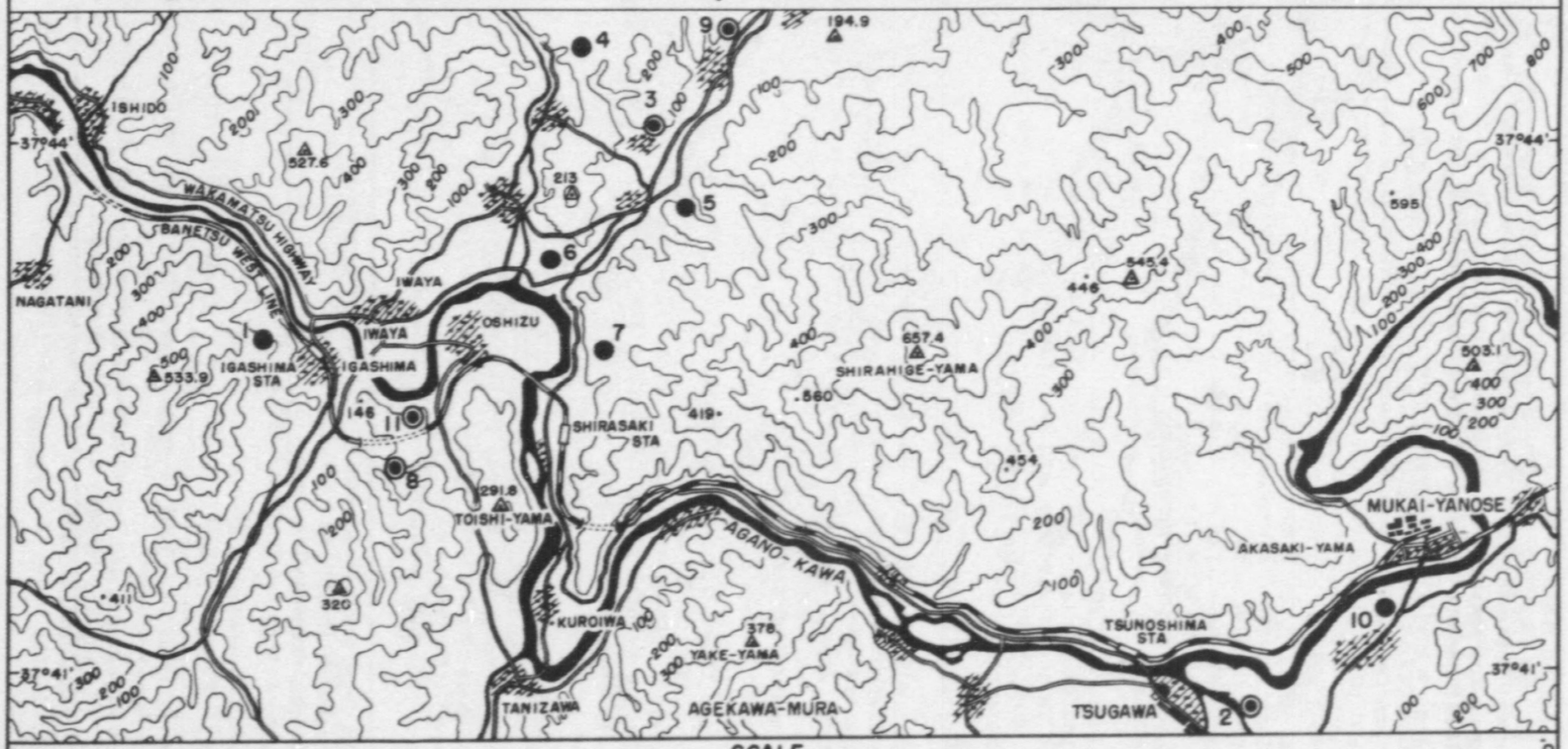
Geology and Mining: Superficial geologic studies have been made of the bentonite in this area, but none is explicit. Apparently the bentonite has resulted from the alteration (mostly hydrothermal) of late Tertiary liparitic tuff and tuff-breccia. Generally the bentonite occurs in isolated or connected masses, rarely more than three meters across, and shaped like potatoes. In some places it occurs as a lenticular mass up to three meters thick. The tuff and tuff-breccia beds containing the bentonite have gentle dips.

A sample from the Teikoku Bentonite Kogyo mine was determined by Dr Grim to be about 60 percent montmorillonite and about 40 percent cristobalite or ash. Sodium appears to be the principal exchangeable base. An analysis, in percent, of the bentonite from the Kirin mine, as determined by the Nagaoka Industrial College Laboratory, Niigata Prefecture, follows:

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O and Na_2O	H_2O	Total
63.14	20.46	2.91	1.93	4.68	3.00	6.85	102.97

With few exceptions the deposits in this area are worked by gopher-holing from hillside adits. Digging and loading are by hand methods. Generally the mining is very unsystematic. Transportation from the mines to the processing plants is by horse-cart and truck. Short aerial trams are used in the vicinity of some of the mines.

BENTONITE MINES AND PROCESSING PLANTS, HIGASHI-KAMBARA-GUN, NIIGATA PREFECTURE, 1949



SCALE
0 1 2 3 4 KILOMETERS

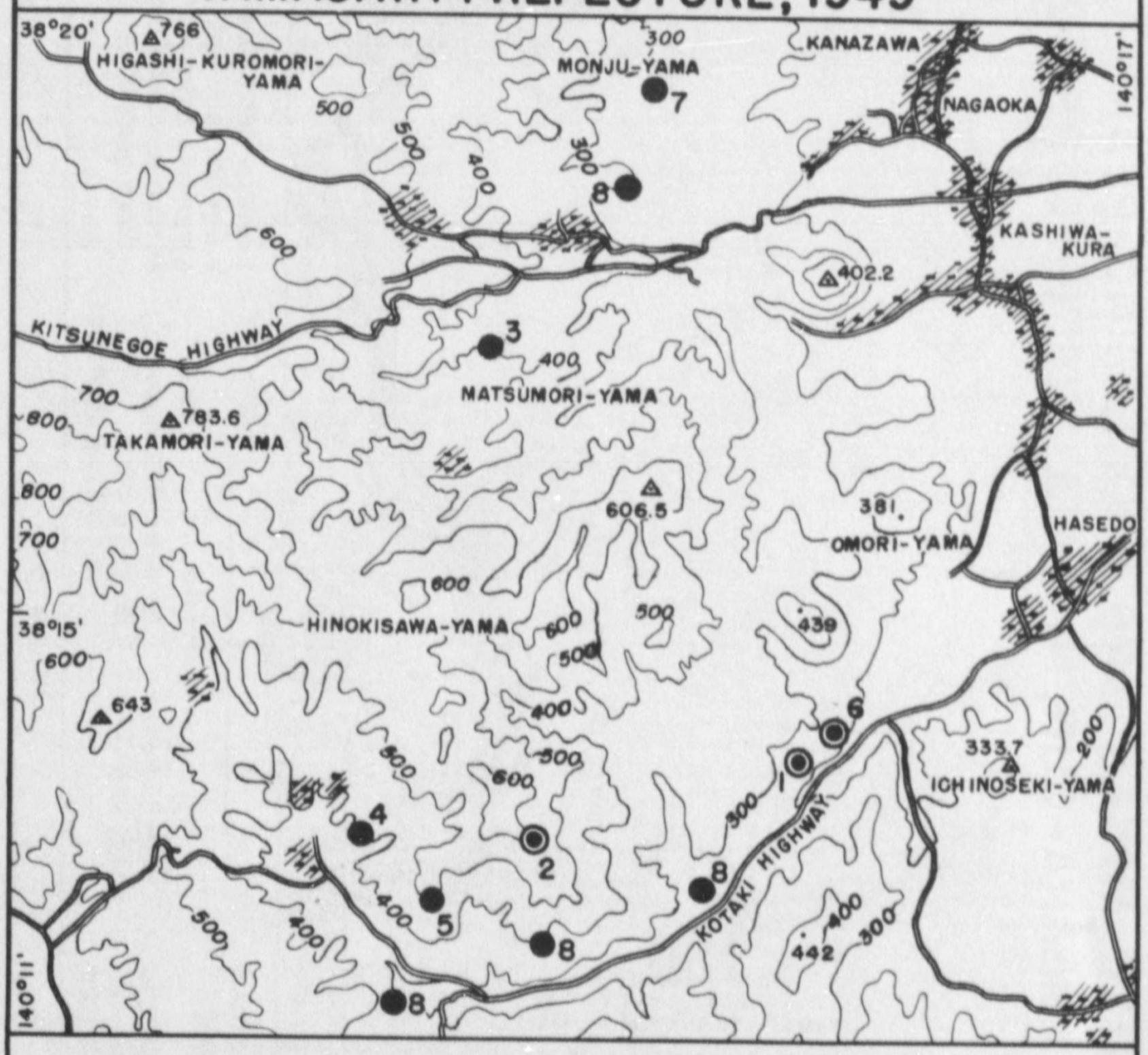
LEGEND
RAILWAY
HAMLET
MINE AND PLANT
MINE ONLY
-300- ELEVATION (METERS)

1 ISOJIMA BENTONITE KOGYO
2 KIRIN BENTONITE KOGYO
3 KONISHI SHOTEN
4 NIPPON BENTONITE KOGYOJO
5 NIPPON BENTONITE KOGYOJO
6 NIPPON BENTONITE KOGYOJO
7 NIPPON BENTONITE KOGYOJO
8 NIPPON BODO KOGYOJO
9 TEIKOKU BENTONITE KOGYO
10 YAKO BENTONITE KOGYO
11 YAKO BENTONITE KOGYO

NATURAL RESOURCES SECTION

Figure 4

BENTONITE MINES AND PROCESSING PLANTS, MINAMI-MURAYAMA-GUN, YAMAGATA PREFECTURE, 1949



NATURAL RESOURCES SECTION

Figure 5

Production: This area produced an estimated 27,000 tons of bentonite in 1943. Since then production has declined gradually; present production from this area is estimated to be about 12,000 tons annually, or about 30 percent of Japan's total.

All processing is done by plants in the area, some plants treating the bentonite of more than one mine. During May-September the crude bentonite is dried in the sun; at other times rotary kilns are employed. Details of the milling process are generally as described in the section on processing methods. The uses of the production from this area, in order of importance, are: foundry sand bond, cosmetics and soaps, and rotary drilling mud.

No data are available on the number of people employed mining and processing bentonite in this area. The labor is almost entirely seasonal, being supplied by local farmers. In October 1947, wages for men averaged ¥70 a day, for women, ¥50.

Probably this area has large reserves of bentonite, but because of its mode of occurrence significant estimates are all but impossible. Also, the mode of occurrence is not conducive to large-scale operations and production.

d. Central Yamagata Prefecture

Location and Accessibility: Ten bentonite mines and three processing plants are operating in central Yamagata Prefecture. All are on AMS L571 (Central Japan), scale 1:250,000, Sheet 10 (Sendai). Seven mines and three processing plants (Figure 5) are in Minami-Murayama-gun, in an area bounded by AMS coordinates 733-738 and 1722-1731, and are on AMS L773 (Northern Honshu), scale 1:50,000, Sheets 6161-I (Yamagata) and 6161-IV (Arato). The Rinsan and Matsurida mines, not shown on Figure 5, are in Hongo-mura, Nishi-Murayama-gun, at AMS coordinates 724.2-1746.5 and 724.1-1746.3, respectively. They are on AMS L773 (Northern Honshu), scale 1:50,000, Sheet 6162-III (Aterazawa), at an altitude of 230 meters. The mines are located 6-15 kilometers from the Ou Main Line, over poor roads.

History and Ownership: Bentonite was first produced in this area about 1940. The Matsurida and Rinsan mines are owned by the Tsukinokawa Kogyosho. Owners of the other mines and mills operating in 1949 are indicated on Figure 5.

Geology and Mining: The bentonite deposits of this area have been derived from a green, liparitic tuff of Miocene age. The tuff is interbedded with liparitic flows and breccia, also of Miocene age. Generally the bentonite-bearing tuff beds have a thickness of two to seven meters. They dip in variable directions at angles up to 80°.

The bentonite deposits are of two main types. The bentonite may comprise the entire thickness of the tuff bed for distances of hundreds of yards along the strike and dip, or it may be confined to potato-shaped masses within the tuff bed, each of these masses containing about one ton of bentonite.

Both hydrothermal and surface alteration acted to form the bentonite. According to Uchida (Bibl 11) the hydrothermal alteration may have been due either to hot spring activity or to large amounts of gases contained in the original eruptives. A sample from the Kokusan mine was determined by Dr Grim to be substantially pure montmorillonite and to carry sodium as the principal exchangeable base.

Most mining in the area is by gopher-holing; methods are generally unsystematic. Mining is complicated by faults which displace the bentonitic tuff beds. The deposits are worked by hand methods. Horse-carts and ox-carts are used for transportation near the mines. Some of the area underlain by bentonite is farm land and cannot be worked.

Production: Production from this area was about 4,000 tons in 1949. The Matsurida mine ships its production to Nishi-nasuno in Tochigi Prefecture for processing All other production is processed in the area. Production from this area is used mostly for soaps, cosmetics, and medicinals. Lesser amounts are used for rotary drilling muds, as a foundry sand bond, and for wall plaster.

Labor is largely seasonal, being supplied by local farmers. Available data indicate that the finished production at the mill is about 100 kilograms per man-day of eight hours, including all labor employed in mining, transportation, and milling. The amount of reserves in the area is not known.

e. Hokkaido

Location and Accessibility: Numerous small bentonite deposits have been reported in Hokkaido. However, only the four from which production has been significant will be described here. The Hattari and Horikappu mines are located at AMS coordinates 781.1-2313.5 and 781.3-2314.0 at altitudes of 220 and 265 meters, respectively. They are on AMS L561 (Northern Japan), scale 1:250,000, Sheet 34 (Shakotan) and on AMS L764 (Hokkaido), scale 1:50,000, Sheet 6276-III (Kayanuma). Both mines are about 12 kilometers over fair roads from the Iwanai station of the Iwanai Line. The Wakamatsu and Kaisei mines are located at AMS coordinates 1083.0-2398.7 and 1082.0-2398.2 at altitudes of 100 and 110 meters, respectively. They are on AMS L561 (Northern Japan), scale 1:250,000, Sheet 37 (Rikumbetsu) and on AMS L764 (Hokkaido), scale 1:50,000, Sheet 6878-II (Nokkeushi). Both mines are about eight kilometers over poor roads from the Nokkeushi station of the Abashiri Main Line. Locations are indicated on Figure 1.

History and Ownership: Probably the first commercial production of bentonite in Hokkaido was about 1940. Owners of the four mines described are: Hattari, Oriental Bentonite Kogyosho; Horikappu, Hokkaido Bentonite Kogyosho; Wakamatsu and Kaisei, Toa Bentonite Kogyosho.

Geology and Mining: Only general information is available on the geology of the Hokkaido deposits. The Horikappu and Hattari deposits are altered portions of a Miocene tuff bed. The tuff bed is about 100 meters thick, is associated with shales and thin coal seams, and dips about 65° west. The Wakamatsu and Kaisei mines work a lenticular bentonite mass, up to 60 meters thick, which occurs in a tuffaceous mudstone of Pliocene age. All the deposits are worked as open pits. No mineralogical studies have been made of these bentonites. Representative analyses of bentonite from the Wakamatsu and Horikappu deposits are shown in Table F.

TABLE F. - REPRESENTATIVE ANALYSES OF BENTONITE FROM WAKAMATSU AND HORIKAPPU MINES, HOKKAIDO
(percent)

Sample	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	MnO	K_2O	Na_2O	TiO_2	Ignition Loss	Total
Wakamatsu a/	67.16	17.66	1.86	3.16	1.08	0.00	0.42	0.90	0.00	7.88	100.12
Horikappu b/	74.90	13.03	11.12	0.86	1.89	0.00	1.10	2.32	0.13	1.95	97.30

a/ Analyzed at Toa Bentonite Kogyosho Laboratory
b/ Analyzed at Tokyo Industrial Experimental Station

Production: The average annual production of bentonite since 1946 by the Hattari, Horikappu, Wakamatsu, and Kaisei mines has been estimated at 2,000, 1,500, 800, and 700 tons respectively. Production in Hokkaido in 1949 was estimated at about 5,000 tons, 12.5 percent of Japan's total. The labor is supplied by local farmers. Hokkaido bentonite is used for a number of purposes but is most important as a fertilizer carrier. The amount of bentonite reserves in Hokkaido is not known, but indications are that they are large.

f. Other Mines

Several small bentonite deposits are worked in Aomori and Akita prefectures, but their production amounts to only about two percent of Japan's total. It is used locally, mostly as a fertilizer carrier and for rotary drilling mud.

Other scattered deposits, some of which have had a small and unimportant production in the past, have been reported in Ishikawa, Tochigi, Miyagi, Shizuoka, and Mie prefectures. Also, a bentonitic clay has been reported associated with coal seams in the Chikuho coal field in northwestern Kyushu. This clay is far below the standards of commercial bentonite and is of academic interest only. It is late Tertiary in age and is found in beds 20 to 60 centimeters thick, some of which can be traced as far as 10 kilometers. 10/

BLEACHING CLAY

1. Historical and General

Naturally adsorptive clays are known to have been produced in Japan since about 1890, and small quantities are thought to have been produced earlier for the local manufacture of soaps and cleansers. The first company in Japan to specialize in the manufacture of activated clay was incorporated in 1923.

2. Production and Consumption

Production data are not available for the years before 1935, but output probably was less than 3,000 tons annually until 1915. Production then rose gradually, the biggest increase coming about 1926, when bleaching clays were first used for oil refining in Japan. Production during 1935-45 averaged about 34,000 tons annually; it dropped to an average of 4,000 tons annually during 1946-49. Production statistics for naturally adsorptive and activated clays in Japan during 1935-49 are summarized in Table G.

Most of the current production is used for petroleum refining; the remainder is used to refine vegetable oils and animal fats.

TABLE G. - PRODUCTION OF BLEACHING CLAY, 1935-49
(metric tons)

Year	Naturally Adsorptive Clay a/	Activated Clay b/	Total
1935	8,583	7,212	15,795
1936	9,156	3,271	12,427
1937	10,330	7,999	18,329
1938	11,240	16,140	27,380
1939	13,192	22,371	35,563
1940	14,049	34,479	48,528
1941	14,225	36,658	50,883
1942	16,347	27,494	43,841
1943	17,673	29,022	46,695
1944	17,846	28,847	46,693
1945	12,688	14,075	26,763
1946	1,686	2,776	4,462
1947	1,857	2,029	3,886
1948	1,460	2,596	4,056
1949 c/	1,300	2,700	4,000
TOTAL	151,632	237,669	389,301

a/ Finished product. About 1.6 tons of clay is mined for each ton of finished product.
b/ Finished product. About 2.7 tons of clay is mined for each ton of finished product.
c/ Estimated
SOURCE: Nippon Kassei Hakudo KK (Japan Activated Earth Co)

10/ Personal communication from K. Kinoshita

TABLE H. - JAPANESE EXPORTS OF BLEACHING CLAY, 1935-44
(metric tons)

Year	Naturally Adsorptive Clay	Activated Clay	Total
1935	4,744	735	5,479
1936	4,882	1,124	6,006
1937	5,524	1,577	7,101
1938	6,330	2,008	8,338
1939	4,528	1,892	6,420
1940	4,370	1,586	5,596
1941	2,365	1,216	3,581
1942	1,985	916	2,901
1943	1,077	1,013	2,090
1944	250	320	570
TOTAL	36,055	12,387	48,442

SOURCE: Nippon Kassei Hakudo KK

Apparently bleaching clays never have been imported into Japan. Substantial quantities are known to have been exported during 1935-44 (Table H). The importing countries were China, Korea, the Philippines, and the Netherlands East Indies, but the amounts taken by each country are not known. The Philippines used the clay for coconut oil refining.

3. Domestic Producing Areas

Niigata Prefecture is by far the most important producer of bleaching clays in Japan. However, Yamagata and Fukushima prefectures also have been commercial producers for many years. Each of these prefectures is described separately later in this report. Locations of principal producing areas are shown in Figure 6.

Numerous smaller deposits of poorer quality have been reported in Hokkaido, Akita, Miyagi, Ibaraki, Aomori, Gumma, Shizuoka, and Tottori prefectures. None of these has been worked commercially, and unless an unprecedented demand develops, Niigata, Yamagata, and Fukushima prefectures will continue to supply Japan's bleaching clay needs.

4. Geology and Mining

The geology of Japan's bleaching clay deposits is included in the discussion of geology in the section on bentonite.

Mining methods also are as described for bentonite, except that wherever gopherholing is employed, the clay is produced through hillside adits.

5. Costs of Production

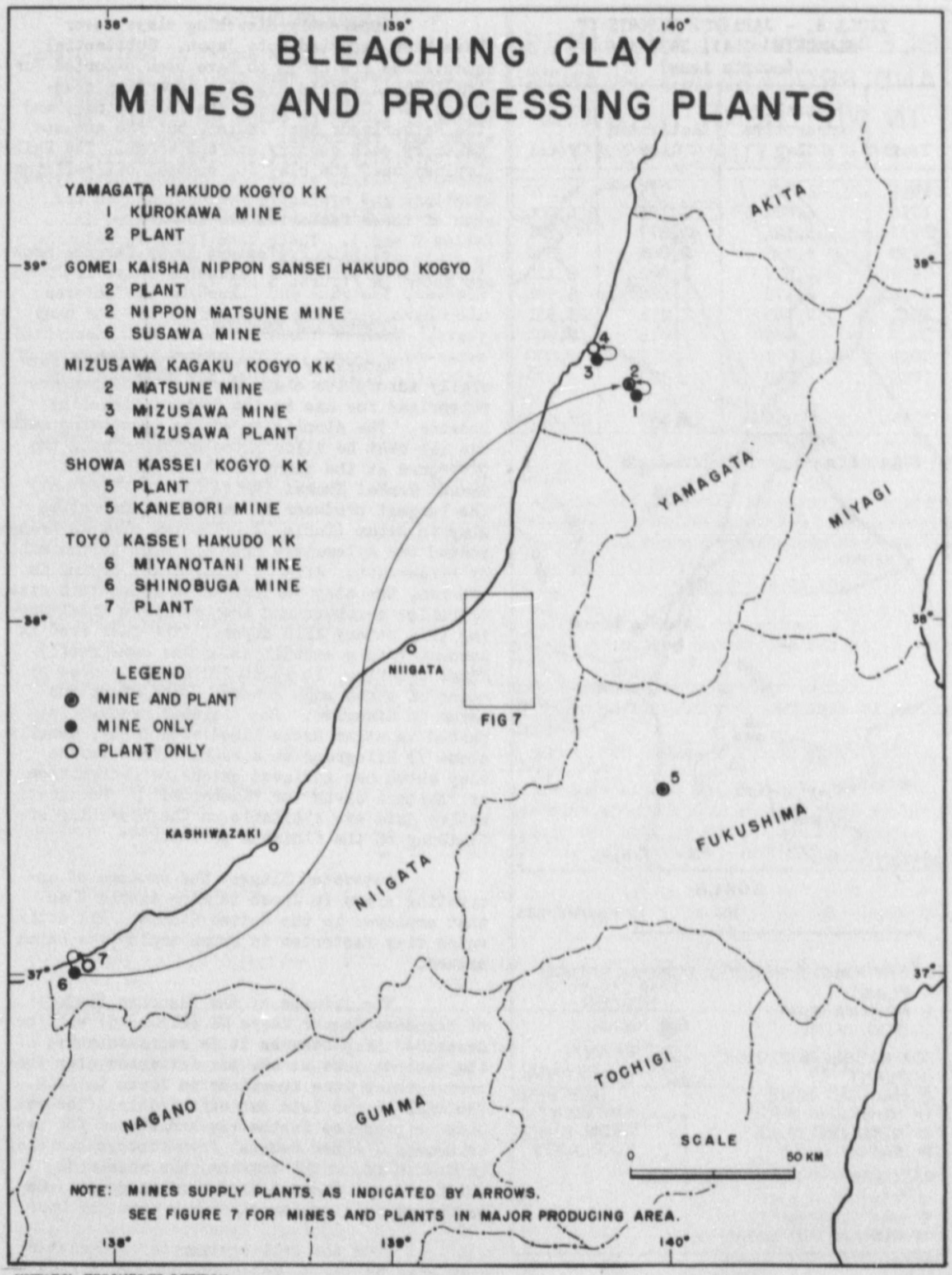
An estimated 340 people were employed in the production of bleaching clay in Japan in 1949. About 100 of these were employed in digging operations, the remainder in processing plants. Both digging and processing are somewhat seasonal operations, because almost one-half of the workers also maintain small farms.

Costs of production for the naturally adsorptive and the activated clays in 1949 are summarized in Table I.

TABLE I. - COSTS OF PRODUCTION OF NATURALLY ADSORPTIVE AND ACTIVATED CLAYS, 1949
(yen per metric ton, FOB factory)

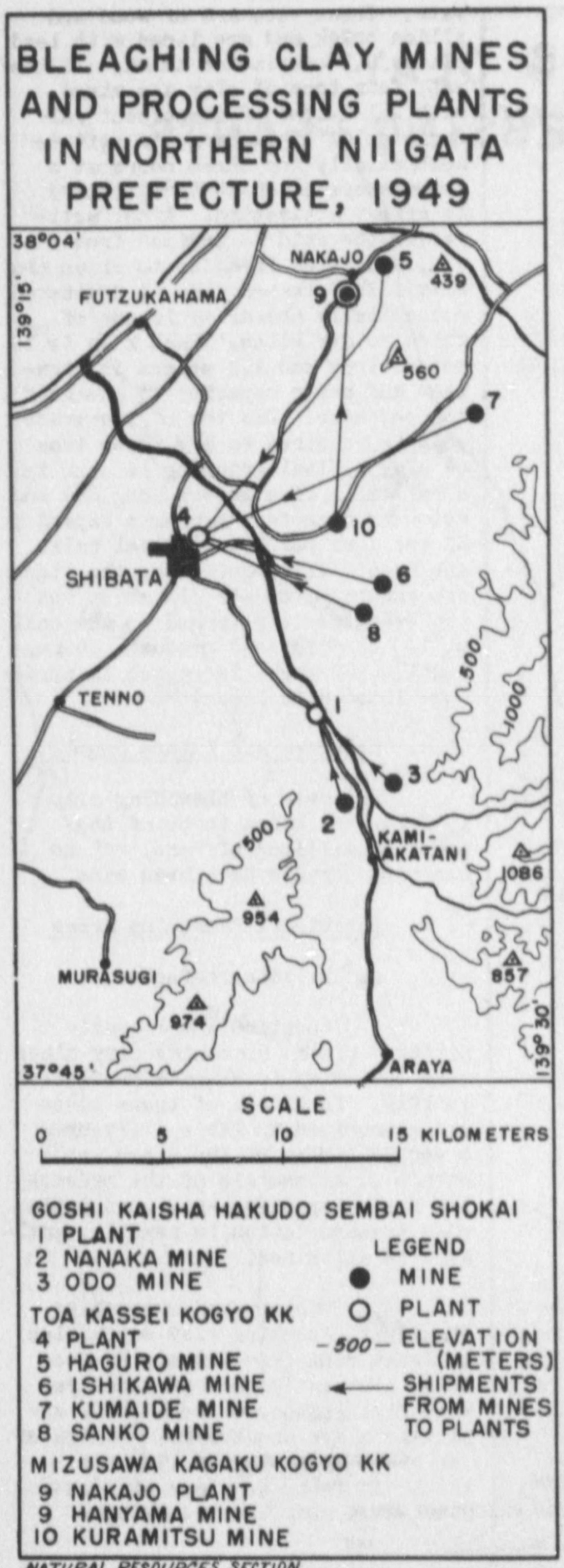
Item	Naturally Adsorptive Clay	Activated Clay
Mining a/	800	1,350
Factory labor	1,155	3,000
Staff	200	700
Sulfuric acid (50° Baumé) b/	NA	7,150
Coal c/	1,440	4,800
Paper sacks (for packing)	780	780
Miscellaneous d/	450	2,100
TOTAL	4,825	19,880

a/ Includes labor and materials. Requirements of raw clay for one ton finished product: naturally adsorptive, 1.6 tons; activated, 2.7 tons.
b/ 1.3 tons at ¥5,500 per ton
c/ For naturally adsorptive clay 0.3 ton, for activated clay one ton, at ¥4,800 per ton.
d/ Includes taxes, welfare fund, and depreciation.
NA: Not applicable
SOURCE: Nippon Kassei Hakudo KK



NATURAL RESOURCES SECTION

Figure 6



NATURAL RESOURCES SECTION
Figure 7

6. Processing Plants

Before 1941 a number of small bleaching clay factories were operating in Japan, but by 1949 more than 95 percent of Japan's output of bleaching clays was produced by eight main factories. Two plants produced only naturally adsorptive clays and five only activated clays, while one produced both types. Locations and available production data for each of these factories are summarized in Tables 2 and 3. Their locations, in relation to their main sources of raw material supply, are shown in Figures 6 and 7.

7. Processing Methods

Naturally Adsorptive Clays: All naturally adsorptive clays produced in Japan are pulverized for use in the contact bleaching process. The simplicity of the processing methods can best be illustrated by describing the procedure at the plant of the Goshi Kaisha Hakudo Sembai Shokai (White Clay Selling Co), the largest producer of naturally adsorptive clay in Japan (Table 3). The raw clay is transported two kilometers from the mine to the mill by horse-cart. After a preliminary drying in the sun, the clay is crushed to a one-inch size by roller crushers and then receives final drying in a rotary kiln dryer. (The fuel used is sawdust from a sawmill under the same roof.) Final crushing, to about 200 mesh, is done by means of stone edge runners, each about one meter in diameter. The finished product is packed in straw sacks lined with paper, usually about 73 kilograms to a sack. (This is the clay which has achieved extensive recognition as "Kambara earth" or "Kambarite".) No quantitative data are available on the bleaching efficiency of the finished product.

Activated Clays: The process of activating clays in Japan is more simple than that employed in the United States. All activated clay factories in Japan employ the batch method.

The process at the Mizusawa factory of Mizusawa Kagaku Kogyo KK (Figure 8) will be described here because it is representative of the methods used at the six activated clay factories which were operating in Japan in 1949. The mill is not laid out efficiently. The raw clay is predried in the sun and stored for use as needed. After removal from storage the clay is broken in a roll crusher, the wheels of which are set about 0.3 centimeter apart. Capacity of this crusher is seven tons per hour.

From the roll crusher the granulated clay goes to one of seven cylindrical mixing

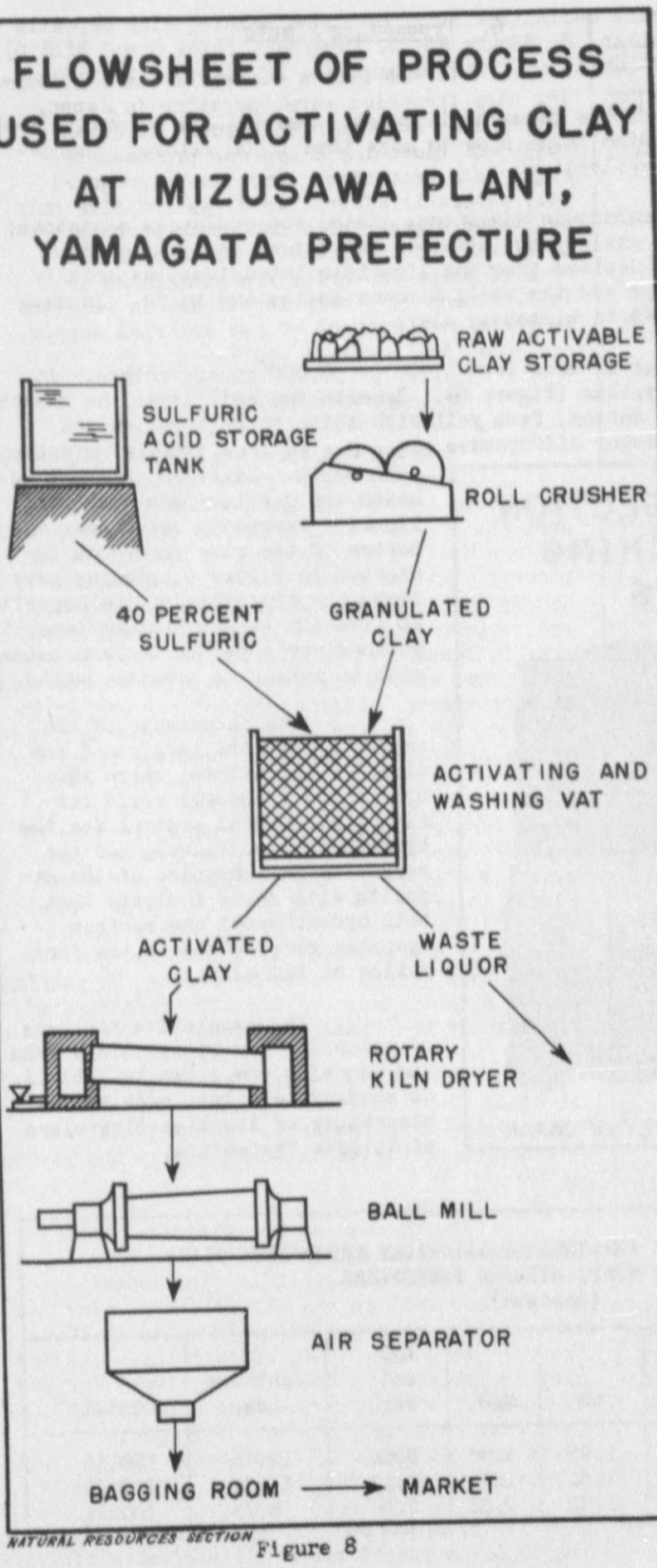


Figure 8

vats. These vats are of wood and silica brick and are lined with lead plates 0.3 centimeter thick. In the vat, four tons of clay are mixed with 2 1/2 tons of 40-percent sulfuric acid. The charge is agitated mechanically for three hours at a temperature of about 90°C (194°F) to effect activation. After activation the acid is drained from the vat, and water is added to clean the clay. The cleaned clay is dewatered mechanically and dried in one of three rotary kilns. Each kiln is 10 meters long and 1.3 meters in diameter and has a capacity of one-half ton per hour. One ton of low-grade coal is required to dry three tons of clay. Final grinding is done in a ball mill five meters long and one meter in diameter, having a capacity of two tons per hour. Steel balls are used. After grinding, the fines are separated by air flotation and the oversize is returned to the ball mill. The finished product, averaging 180-200 mesh, is packed in straw bags lined with paper.

8. Reserves and Future Supply

Reserves of bleaching clay in Japan are known to be of the order of millions of tons, but no accurate surveys have been made.

9. Individual Producing Areas

a. Niigata Prefecture

Location and Accessibility: Eleven bleaching clay mines were operating in Niigata Prefecture in 1949. Locations of these mines are summarized in Table 4 (Figures 6 and 7). Most of the mines are within 10 kilometers of the processing factories they serve, and railroad transportation is readily available to all mines.

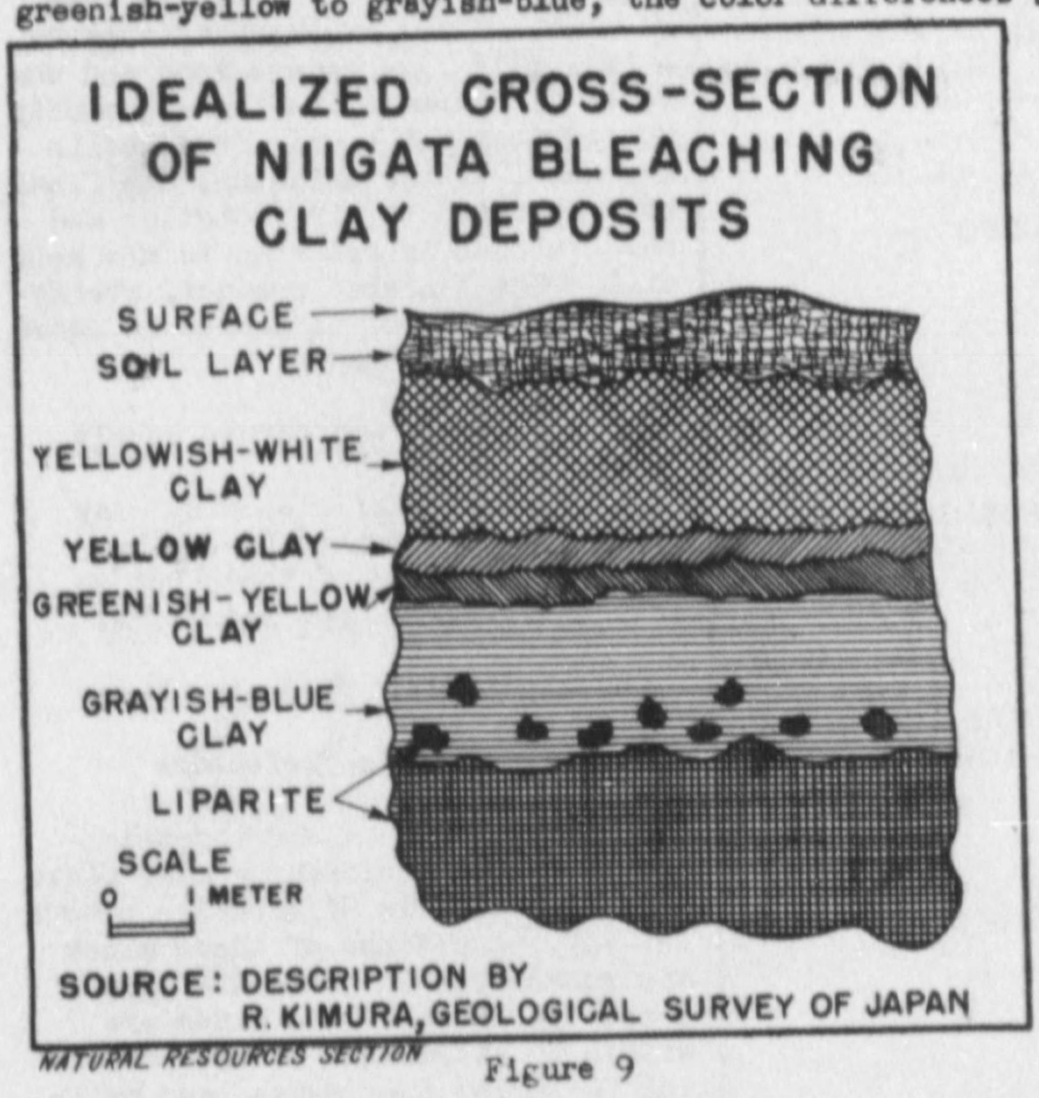
History and Ownership: The first bleaching clay production in Japan came from Niigata Prefecture. Naturally adsorptive clays were first produced about 1890, activable clays about 1920. Owners of the mines operating in 1949 are listed in Table 4. Many abandoned pits exist near these workings.

Geology and Mining: A more definitive study of the bleaching clay deposits of Niigata Prefecture is needed. However, R. Kimura and K. Kobayashi (Bibl 5 and Bibl 6), in separate studies, have made a good beginning. This discussion is based on their work.

The terrain in the area of the deposits is rough. The valleys generally are less than 200 meters in altitude, and the peaks rise to more than 1,400 meters. The deposits which are worked occur in the valleys.

The area is composed of Paleozoic limestone, slate, and graywacke sandstone; Mesozoic granites; and Miocene tuffs, shales, and liparitic intrusives and extrusives. Most of the bleaching clays have been derived from the liparitic intrusives, especially near the contact between the intrusives and the early Miocene shales and tuffs. In some places the tuffs also have been changed to bleaching clay.

The deposits studied range in area from 1,500 to 50,000 square meters. In profile the individual deposits are similar (Figure 9). Beneath the soil layer the bleaching clay grades in color, from top to bottom, from yellowish-white through yellow and greenish-yellow to grayish-blue, the color differences being due to less intense oxidation with depth. Liparite is found beneath the grayish-blue clay, and liparite fragments occur near the bottom of the clay zone. As indicated in Figure 9, studies have fixed the thickness of the deposits at five-six meters; future investigations may show the surface oxidation to extend to greater depths.



NATURAL RESOURCES SECTION

Figure 9

The occurrence of the deposits near the margins of the liparite intrusives, where the cracks and fractures would furnish a structural control for the hydrothermal solutions, and the variation in the color of the deposits with depth indicate that both hydrothermal and surface agencies were active in the formation of the clay.

Representative analyses of naturally adsorptive clays from the Odo mine are shown in Table J. No studies have been made on the mineralogy of the bleaching clays of Niigata Prefecture.

TABLE J. - REPRESENTATIVE ANALYSES OF NATURALLY ADSORPTIVE CLAYS FROM ODO MINE, NIIGATA PREFECTURE
(percent)

Clay	SiO_2	Al_2O_3	Fe_2O_3 and FeO	CaO	MgO	K_2O and Na_2O	Ignition Loss	Total
White	66.35	15.07	2.51	1.07	1.08	0.64	12.76	99.48
Yellow	63.76	14.33	2.27	1.54	2.28	0.43	15.55	100.16
Blue	70.99	15.76	2.86	1.82	2.38	0.58	5.75	100.14

SOURCE: K. Kobayashi (Bibl 6)

Most of the deposits are worked by simple open pit methods. A few of the deposits are approached by hillside adits and worked by gopher-holing methods.

Production: Available past production data are summarized in Table 5, along with consuming factories. Reserves in Niigata are thought to exceed 1,000,000 tons.

b. Yamagata Prefecture

Location and Accessibility: Four bleaching clay mines were operating in Yamagata Prefecture in 1949. Locations of these mines are summarized in Table 6 (see also Figure 6). Railroad transportation is easily available to all mines.

History and Ownership: Naturally adsorptive clay was first produced in Yamagata Prefecture about 1925, activable clays in 1935. Owners of the four mines operating in 1949 are listed in Table 6.

Geology and Mining: The area of these deposits is made up of early Tertiary sandstones, shales, pyroclastics, and liparite intrusives and extrusives. Probably the deposits are similar to those of Niigata Prefecture in occurrence and origin, but no study has been made of the Yamagata deposits. All Yamagata deposits are worked as open pits.

Production: Little is known about past production in Yamagata Prefecture. Available information is summarized in Table 7.

c. Fukushima Prefecture

The Kanebori mine is located at Kanebori, Ikki-mura, Kita-Aizu-gun, Fukushima Prefecture. It is at coordinates 708.5-1642.5 on AMS L571 (Central Japan), scale 1:250,000, Sheet 15 (Numasawa-Numa) and on AMS L773 (Northern Honshu), scale 1:50,000, Sheet 6051-I (Kitakata).

The mine is owned by Showa Kassei Kogyo KK and has produced activable clay since 1925. Estimated production for the mine during 1925-49 is 16,000 tons, all of which was processed at the company's Kanebori factory less than one kilometer from the mine. The deposit is worked as an open pit. No information is available on geology or reserves.

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GLOSSARY

1. Conversion Factors

Metric		English
1 metric ton	=	1.102 short tons
1 kilogram	=	2.205 pounds
1 kilometer	=	0.621 mile

Metric		English
1 meter	=	3.281 feet
1 square meter	=	10.764 square feet
1° centigrade x 9/5 + 32	=	1° Fahrenheit

2. Japanese Terms

-gawa	river	-machi	town
-gun	county	-mura	village
Kabushiki Kaisha (KK)	company limited	-san	mountain
-kawa	river	-yama	mountain
		-zan	mountain

11/ Translations from the Japanese, noted in references, were made for use in the preparation of this report and are not in published form.
12/ Literally, acid white clay.
13/ Literally, swelling hygroscopic clay.

TABLE 1.- LOCATIONS OF BENTONITE MINES AND PROCESSING PLANTS IN NORTHERN NAGANO PREFECTURE, 1949

Mine or Plant	Owner	Geographical Location	AMS Coordinates		Sheet Number on AMS Maps		Accessibility
			EW	NS	1:250,000 a/	1:50,000 b/	
Kobayashi Mine	Kobayashi Sangyo Yugen Kaisha	Maki-mura, Higashi-Kubiki-gun, Niigata Pref c/	1331.7	1587.6	14 (Takada)	5758-II (Arai)	18 km from Takada station, Shinetsu Main Line
Kobayashi Plant	Kobayashi Sangyo Yugen Kaisha	Hotaka-machi, Minami-Azumi-gun, Nagano Pref	1284.5	1496.8	19 (Toyama)	5655-I (Matsumoto)	500 meters from Hokuyacho station, Oita South Line
Kuroguchi mine and plant	Kingo Bentonite Kogyojo	Yashiro-machi, Chiisagata-gun, Nagano Pref	1312.2	1539.5	20 (Nagano)	5756-IV (Nagano)	2 km from Yashiro station, Shinetsu Main Line
Kurokawachi mine and plant	Kurokawachi Bentonite Kogyojo	Ono-mura, Kami-ina-gun, Nagano Pref	1292.5	1462.8	19 (Toyama)	5655-II (Chiojiri)	1 km from Ono station, Chuo Main Line
Ono mine and plant	Ono Bentonite Kogyojo	Kyowa-mura, Sarashina-gun, Nagano Pref	1306.2	1533.4	20 (Nagano)	5756-IV (Nagano)	5 km from Kawanakajima station, Shinetsu Main Line
Toyo mine and plant	Toyo Bentonite Kogyo KK	Nagano-shi, Nagano Pref	1525.0	1307.4	20 (Nagano)	5756-IV (Nagano)	2 km from Nagano station, Shinetsu Main Line

a/ L571 (Central Japan)
b/ L774 (Central Honshu) except Kobayashi mine, which is on L773 (Northern Honshu).
c/ This mine is considered part of the Nagano group.

TABLE 2.- LOCATIONS OF PRINCIPAL BLEACHING CLAY PROCESSING PLANTS, 1949

Plant Owner a/	Geographical Location	AMS Coordinates		Sheet Number on AMS Maps	
		EW	NS	1:250,000 b/	1:50,000 c/
Gomei Kaisha Nippon Sansei Hakudo Kogyo	Kurokawa-machi, Higashi-Tagawa-gun, Yamagata Pref	702	1780	9 (Iwafune)	6062-I (Yudono-San)
Goshi Kaisha Hakudo Sembai Shokai	Kawahigashi-mura, Kita-Kambara-gun, Niigata Pref	653	1689.5	15 (Numazawa-Numa)	5960-I (Shibata)
Mizusawa Kagaku Kogyo KK Mizusawa Plant	Kamigo-mura, Nishi-Tagawa-gun, Yamagata Pref	689.5	1790.5	9 (Iwafune)	6063-III (Sanse)
Nakajo Plant	Nakajo-machi, Kita-Kambara-gun, Niigata Pref	655	1708	9 (Iwafune)	5961-II (Nakajo)
Showa Kassei Kogyo KK	Ikki-mura, Kita-Aizu-gun, Fukushima Pref	708	1642	15 (Numazawa-Numa)	6059-II (Kitakata)
Toa Kassei Kogyo KK	Shibata-shi, Niigata Pref	648	1697	15 (Numazawa-Numa)	5960-I (Shibata)
Toyo Kassei Hakudo KK	Itoigawa-machi, Nishi-Kubiki-gun, Niigata Pref	1279	1584	13 (Noto East)	5658-II (Itoikawa)
Yamagata Hakudo Kogyo KK	Kurokawa-machi, Higashi-Tagawa-gun, Yamagata Pref	702	1780	9 (Iwafune)	6062-I (Yudono-San)

a/ English translations for company names, listed in order: Japan Activated Clay Co; White Clay Selling Co; Mizusawa Chemical Industry Co Ltd; Showa Activating Industry Co Ltd; Toa Activating Industry Co Ltd; Toyo Activated Earth Co Ltd; Yamagata White Earth Industry Co Ltd.
b/ L571 (Central Japan)
c/ L773 (Northern Honshu)

TABLE 3.- CAPACITIES AND PAST PRODUCTION OF PRINCIPAL BLEACHING CLAY PLANTS, 1949

Plant Owner	Year of First Production	Annual Capacity (MT)		Past Production a/ (MT)
		Naturally Adsorptive Clay	Activated Clay	
Gomei Kaisha Nippon Sansei Hakudo Kogyo	1935	NA	3,000	28,000, 1935-49
Goshi Kaisha Hakudo Sembai Shokai	Before 1900	9,000	NA	8,000-9,000 annually, 1935-41
Mizusawa Kagaku Kogyo KK Mizusawa plant	1937	NA	9,600	58,000, 1937-46
Nakajo plant	1944	NA	12,000	5,000, 1944-49
Showa Kassei Kogyo KK	1925	NA	1,000	8,000, 1925-49
Toa Kassei Kogyo KK	1942	NA	2,500	8,000, 1942-49
Toyo Kassei Hakudo KK	Before 1925	6,000	8,400	80,000 b/, 1925-49
Yamagata Hakudo Kogyo KK	Before 1925	1,800	NA	30,000, 1925-49

a/ All amounts are estimated except that for Goshi Kaisha Hakudo Sembai Shokai, which is considered to be accurate. As nearly as can be determined, these totals are less than the over-all figures presented in Table G. This discrepancy probably could be resolved if production totals were available for the smaller factories which have suspended operations since 1941.
b/ 50,000 tons of naturally adsorptive clay and 30,000 tons of activated clay
NA: Not applicable
SOURCE: Individual factory owners

TABLE 4.- LOCATIONS OF BLEACHING CLAY MINES IN NIIGATA PREFECTURE, 1949

Mine	Owner	Geographical Location	AMS Coordinates		Sheet Number on AMS Map	
			EW	NS	1:250,000 a/	1:50,000 b/
Haguro	Toa Kassei Kogyo KK	Nakajo-machi, Kita-Kanbara-gun	657.0	1709.6	9 (Iwafune)	5961-II (Nakajo)
Hanyama	Mizusawa Kagaku Kogyo KK	Nakajo-machi, Kita-Kanbara-gun	656.5	1708.8	15 (Numasawa-Numa)	5961-II (Nakajo)
Ishikawa	Toa Kassei Kogyo KK	Sugatani-mura, Kita-Kanbara-gun	657.3	1697.3	15 (Numasawa-Numa)	5960-I (Shibata)
Kumaide	Toa Kassei Kogyo KK	Sugatani-mura, Kita-Kanbara-gun	661.3	1702.8	15 (Numasawa-Numa)	5960-I (Shibata)
Kuramitsu	Mizusawa Kagaku Kogyo KK	Sugatani-mura, Kita-Kanbara-gun	654.5	1697.3	15 (Numasawa-Numa)	5960-I (Shibata)
Miyanotani	Toyo Kassei Hakudo KK	Imai-mura, Nishi-Kubiki-gun	1275.7	1582.1	13 (Noto East)	5658-II (Itoikawa)
Nanaka	Goshi Kaisha Hakudo Senbai Shokai	Yonekura-mura, Kita-Kanbara-gun	654.5	1685.5	15 (Numasawa-Numa)	5960-I (Shibata)
Odo	Goshi Kaisha Hakudo Senbai Shokai	Kawahigashi-mura, Kita-Kanbara-gun	655.5	1687.5	15 (Numasawa-Numa)	5960-I (Shibata)
Sanko	Toa Kassei Kogyo KK	Kawahigashi-mura, Kita-Kanbara-gun	656.5	1696.0	15 (Numasawa-Numa)	5960-I (Shibata)
Shinobuga	Toyo Kassei Hakudo KK	Imai-mura, Nishi-Kubiki-gun	1276.8	1581.5	13 (Noto East)	5658-II (Itoikawa)
Susawa	Gomei Kaisha Nippon Sansei Hakudo Kogyo	Imai-mura, Nishi-Kubiki-gun	1276.0	1581.5	13 (Noto East)	5658-II (Itoikawa)

a/ L773 (Northern Honshu)
b/ L571 (Central Japan)

TABLE 5.- PRODUCTION OF NATURALLY ADSORPTIVE AND ACTIVABLE CLAYS BY MINES IN NIIGATA PREFECTURE

Mine	Date of First Operation	Estimated Past Production (metric tons)	Processing Plant Supplied a/
Haguro	1942	Activable: 2,500, 1942-49	Toa Kassei Kogyo KK
Hanyama	1944	Activable: 5,000, 1944-49	Nakajo factory, Mizusawa Kagaku Kogyo KK
Ishikawa	1942	Activable: 6,000, 1942-49	Toa Kassei Kogyo KK
Kumaide	1942	Activable: 1,300, 1942-49	Toa Kassei Kogyo KK
Kuramitsu	1944	Activable: 4,000, 1944-49	Nakajo factory, Mizusawa Kagaku Kogyo KK
Miyanotani	Before 1925	Naturally adsorptive and activable: 75,000, 1925-49	Toyo Kassei Hakudo KK
Nanaka	Before 1900	Naturally adsorptive: 1,000 annual average, 1937-45; 300 annual average, 1946-49	Goshi Kaisha Hakudo Senbai Shokai
Odo	Before 1900	Naturally adsorptive: 8,000 annual average, 1937-45; 1,000 annual average, 1946-49	Goshi Kaisha Hakudo Senbai Shokai
Sanko	1942	Activable: 600, 1942-49	Toa Kassei Kogyo KK
Shinobuga	Before 1925	Naturally adsorptive and activable: 4,500, 1925-49	Toyo Kassei Hakudo KK
Susawa	1935	Activable: 45,000, 1935-49	Gomei Kaisha Nippon Sansei Hakudo Kogyo

a/ These plants may have received additional supplies in the past from mines which since have ceased producing.
SOURCE: Individual companies

TABLE 6.- LOCATIONS OF BLEACHING CLAY MINES IN YAMAGATA PREFECTURE, 1949

Mine	Owner	Geographical Location	AMS Coordinates		Sheet Number on 1:50,000 Maps a/
			EW	NS	
Kurokawa	Yamagata Hakudo Kogyo KK	Kurokawa-mura, Higashi-Tagawa-gun	703.5	1778.5	6062-I (Yudono-San)
Matsune	Mizusawa Kagaku Kogyo KK	Kurokawa-mura, Higashi-Tagawa-gun	702.4	1779.4	6062-I (Yudono-San)
Misusawa	Mizusawa Kagaku Kogyo KK	Kamigo-mura, Nishi-Tagawa-gun	689.7	1787.4	6063-III (Sanse)
Nippon Matsune	Gomei Kaisha Nippon Sansei Hakudo Kogyo	Kurokawa-mura, Higashi-Tagawa-gun	702.9	1779.8	6062-I (Yudono-San)

a/ L773 (Northern Honshu). All mines are on AMS L571 (Central Japan), scale 1:250,000, Sheet 9 (Iwafune).

TABLE 7.- PRODUCTION OF NATURALLY ADSORPTIVE AND ACTIVABLE CLAYS BY MINES IN YAMAGATA PREFECTURE

Mine	Date of First Operation	Estimated Past Production (metric tons)	Processing Plant Supplied a/
Kurokawa	About 1925	Naturally adsorptive: 50,000, 1925-49	Yamagata Hakudo Kogyo KK
Matsune	1937	Activable: 25,000, 1937-49	Misusawa factory, Misusawa Kagaku Kogyo KK
Misusawa	1937	Activable: 98,000, 1937-49	Misusawa factory, Misusawa Kagaku Kogyo KK
Nippon Matsune	1935	Activable: 32,000, 1935-49	Gomei Kaisha Nippon Sansei Hakudo Kogyo

a/ These plants may have received additional supplies in the past from mines which since have ceased producing.
SOURCE: Individual companies

NATURAL RESOURCES SECTION
REPORT NUMBER 139
January 1951

LIST OF NATURAL RESOURCES SECTION REPORTS

Report No	1.	Possibility of Reparations From Japan's Natural Resources	31 Oct 45
Report No	2.	Food Position of Japan Proper for 1945 and 1946	13 Nov 45
Report No	3.	Basic Problems of the Coal Mining Industry in Japan	14 Nov 45
Report No	4.	Culture and Utilisation of "Kozo" and "Mitsumata" for the Manufacture of High-Grade Paper in Japan	24 Nov 45
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Report No	6.	Administration of the Japanese Mining Industry	1 Dec 45
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Report No	8.	Stockpiles of Logs and Lumber in Japan	11 Dec 45
Report No	9.	Unusual Materials as Foodstuffs in Japan	17 Dec 45
Report No	10.	Food Position of Japan Proper in 1946	27 Dec 45
Report No	11.	Estimate of the Forestry Situation in Hokkaido	22 Dec 45
Report No	12.	Sources of Phosphate for Japan	31 Dec 45
Supplement:		Sources of Phosphate for Japan	15 Mar 46
Report No	13.	Forest Areas, Forest Composition, and Standing Timber by Volume in Japan	10 Jan 46
Report No	14.	Production of the Fishing Industry of Hokkaido	20 Jan 46
Report No	15.	Livestock Feed Requirements for Japan Proper	21 Jan 46
Report No	16.	Soils of Kyushu and Southern Honshu	26 Jan 46
Report No	17.	Wartime Administration of the Japanese Mineral Industry	29 Jan 46
Report No	18.	Oil Fields of Hokkaido	2 Feb 46
Report No	19.	Soils of Hokkaido and Northern Honshu	4 Feb 46
Report No	20.	Vegetable Seeds in Relation to Food Supply in Japan	14 Feb 46
Report No	21.	The Coal Industry of Japan in Recent Years	20 Feb 46
Report No	22.	Japanese Fishing Areas	25 Feb 46
Report No	23.	Korean Mineral Industry Statistics	18 Mar 46
Report No	24.	Foodstuffs Used in the Manufacture of Alcoholic Beverages in Japan	22 Mar 46
Report No	25.	Characteristics of the Japanese Agricultural Cooperative Association	27 Mar 46
Report No	26.	Estimate of the Charcoal and Firewood Situation in Japan	1 Apr 46
Report No	27.	Production, Consumption, and Stockpiles of Bamboo	5 Apr 46
Report No	28.	Estimate of the Pulpwood Situation in Japan	15 Apr 46
Report No	29.	The Honkeiko Colliery Disaster	18 Apr 46
Report No	30.	The Livestock Industry in Japan	18 Apr 46
Report No	31.	The Japanese Salmon Industry	25 Apr 46
Report No	32.	Lumber Production in Japan	26 Apr 46
Report No	33.	Commercial Fertilizers in Korea	6 May 46
Report No	34.	Veneer and Plywood Manufacturing in Japan	8 May 46
Report No	35.	The Mineral Industry of Korea in 1944	14 May 46
Report No	36.	Food Position of Japan for the Rice Year 1946 (Revised Mar 46)	4 May 46
Report No	37.	Fisheries Education and Research in Japan	31 May 46
Report No	38.	A Survey of Timber Control in Japan Since 1941	10 Jun 46
Report No	39.	Hydroelectric Power in Japan	12 Jun 46
Report No	40.	Forestry Situation in Kyushu	17 Jun 46
Report No	41.	Japanese Research Institutions in the Field of Mining and Geology	25 Jun 46
Report No	42.	Japanese Agar-Agar Industry	28 Jun 46
Report No	43.	Hydrology of Japan	1 Jul 46
Report No	44.	Mineral Resources of Japan Proper 1925-1945	5 Jul 46
Report No	45.	Statistics of Fruit Production in Japan 1926 to 1946	12 Jul 46
Report No	46.	The Imperial Forests of Japan	19 Jul 46
Report No	47.	The Forestry Situation in Southern Korea	26 Jul 46
Report No	48.	Forestry and Forest Industries in Shikoku	31 Jul 46
Report No	49.	Japanese Petroleum Drilling Methods and Equipment	7 Aug 46
Report No	50.	Iron and Steel Metallurgy of the Japanese Empire	31 Oct 46
Report No	51.	Forestry Education in Japan	16 Aug 46
Report No	52.	Economic Controls in the Japanese Coal Industry	21 Aug 46
Report No	53.	Dolomite Resources in Japan	26 Aug 46
Report No	54.	Cobalt Resources in Japan	31 Aug 46
Report No	55.	Fertilizer in Japan	10 Sep 46
Report No	56.	The Wood Pulp Industry in Japan	15 Sep 46
Report No	57.	Nickel Deposits in Japan	30 Sep 46
Report No	58.	The Forestry Situation in Northern Honshu	10 Oct 46
Report No	59.	The Agricultural Experiment Stations of Japan	15 Oct 46
Report No	60.	Limestone, Lime, and Gypsum Resources in Japan	15 Nov 46
Supplement:		Descriptions of Gypsum Producing Areas and Mines	30 Nov 46
Supplement:		Limestone Production and Consumption	26 Jul 48
Report No	61.	Tungsten and Molybdenum Metallurgy of Japan	30 Nov 46
Report No	62.	Ferroalloy Metallurgy of Japan	5 Dec 46
Report No	63.	Glossary of Japanese Fisheries Terms	23 Dec 46
Report No	64.	Chromite Resources of Japan	15 Jan 47
Supplement:		Descriptions of Chromite Producing Areas and Mines	28 Mar 47
Report No	65.	Zinc-Lead Resources of Japan	30 Jan 47
Supplement:		Descriptions of Zinc-Lead Producing Areas and Mines	6 Jul 48
Report No	66.	Sulfur Resources of Japan	10 Feb 47
Supplement:		Descriptions of Japanese Sulfur Producing Areas and Mines	5 Mar 47
Report No	67.	Barite Resources in Japan	11 Feb 47
Report No	68.	Fushun Coal Field, Manchuria	17 Feb 47
Report No	69.	Iron Ore Resources of Japan	26 Feb 47
Supplement:		Descriptions of Iron Ore Producing Areas and Mines	21 Apr 47
Report No	70.	Pyrite Resources of Japan	4 Mar 47
Supplement:		Descriptions of Pyrite Producing Areas and Mines	7 Jun 47
Report No	71.	Japanese Fishing Gear	5 Mar 47
Report No	72.	Molybdenum in Japan	14 Mar 47
Report No	73.	Japanese Whaling in the Bonin Island Area	4 Apr 47
Report No	74.	Low-Temperature Carbonization of Coal in Japan	16 Apr 47
Report No	75.	Fluorspar Resources of Japan	18 Apr 47
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Report No	77.	Tungsten Resources of Japan	29 Apr 47
Report No	78.	Pyrethrum in Japan	9 May 47
Report No	79.	Farm Tenancy in Japan	25 Jun 47
Report No	80.	Petroleum Resources and Production in Japan	25 Jun 47
Report No	81.	Graphite Resources of Japan	30 Jun 47
Report No	82.	Tin Metallurgy in Japan	7 Jul 47
Report No	83.	Lead Metallurgy in Japan	18 Jul 47
Report No	84.	Mineral Resources of Southern Korea	28 Jul 47
Report No	85.	Magnesium Metallurgy in the Japanese Empire	6 Aug 47
Report No	86.	Field Experiments with Fertilizers in Japan	18 Aug 47
Report No	87.	Aluminum Metallurgy in the Japanese Empire	26 Aug 47
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Report No	90.	Bark Beetle Epidemic in Japan	5 Sep 47
Report No	91.	Mercury Resources of Japan	10 Sep 47
Report No	92.	Antimony Resources of Japan	17 Sep 47
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Report No	94.	Japanese Food Crop Diseases and Control	10 Oct 47
Report No	95.	Japanese Fisheries Production, 1908-46	15 Oct 47
Report No	96.	Zinc Metallurgy in Japan	25 Oct 47
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Report No	98.	Iron Sand Resources of Japan	15 Nov 47
Supplement:		Descriptions of Iron Sand Mines	17 Jul 48
Report No	99.	Ishikari Coal Field, Hokkaido	28 Nov 47
Report No	100.	Metallic Manganese Metallurgy in Japan	18 Dec 47
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Report No	102.	Japanese Ornithology and Mammalogy During World War II	30 Jan 48
Report No	103.	The Coal Fields of Kyushu	10 Feb 48
Report No	104.	The Japanese Tuna Fisheries	9 Mar 48
Report No	105.	Cement Industry of Japan	29 Apr 48

Continued

LIST OF NATURAL RESOURCES SECTION REPORTS (CONTINUED)

Report No 106.	Copper in Japan	30 Apr 48
Report No 107.	Petroleum and Natural Gas Production in Japan, 1946 Fiscal Year	8 Jun 48
Report No 108.	Crop Statistics for Japan, 1878-1946	29 Jun 48
Report No 109.	Canned Crab Industry of Japan	26 Jul 48
Report No 110.	Reconnaissance Soil Survey of Japan	
	A. Kanto Plain Area	5 Aug 48
	B. Kyushu	17 Feb 50
	C. Kyoto Area	Jun 50
	D. Shikoku	Sep 50
	E. Hiroshima Area	Nov 50
Report No 111.	English-Japanese Terms, Mining and Petroleum Industry	23 Aug 48
Report No 112.	Lignite in Japan	31 Aug 48
Report No 113.	Reforestation in Japan	18 Sep 48
Report No 114.	Mining Practices at Matsuo Pyrite Mine, Japan	23 Sep 48
Report No 115.	Asbestos Resources of Japan	22 Oct 48
Report No 116.	Wildlife Conservation in Japan	30 Nov 48
Report No 117.	Aquatic Resources of the Ryukyu Area	31 Dec 48
Report No 118.	Waterfowl of Japan	17 Jan 49
Report No 119.	Important Trees of Japan	30 Mar 49
Report No 120.	Coal Fields of Eastern Honshu, Japan	26 Apr 49
Report No 121.	Systematic List of Economic Plants in Japan	21 Oct 49
Report No 122.	Pearl Culture in Japan	31 Oct 49
Report No 123.	High-Yield Pulping Processes in Japan	3 Nov 49
Report No 124.	Newsprint in Japan	15 Dec 49
Report No 125.	Tea in Japan	23 Dec 49
Report No 126.	Japanese Whaling Industry Prior to 1946	1 Mar 50
Report No 127.	Japanese Land Reform Program	15 Mar 50
Report No 128.	Gold and Silver in Japan	Jun 50
Report No 129.	Japanese Fur Sealing	Jul 50
Report No 130.	Fire Clay Resources of Japan	Jul 50
Report No 131.	Glossary of Japanese Forestry Terms	Jul 50
Report No 132.	Coal Fields of Western Honshu, Japan	Jul 50
Report No 133.	Coal Fields of Hokkaido, Japan (Other than Ishikari)	Aug 50
Report No 134.	Oyster Culture in Japan	Sep 50
Report No 135.	Whiteware Raw Material Resources of Japan	Oct 50
Report No 136.	The Japanese Village in Transition	Nov 50
Report No 137.	Metallurgical Plants of Japan	Dec 50
Report No 138.	Japanese Offshore Trawling	Dec 50
Report No 139.	Bentonite and Bleaching Clay in Japan	Jan 51

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No 1.	Formosan Metal and Mineral Statistics	29 Oct 46
No 2.	Coke in Japan	15 Nov 46
No 3.	Quality and Uses of Japanese Coal and Lignite	31 Dec 46
No 4.	Food Position of Japan for the 1947 Rice Year (as of 1 Nov 46)	3 Feb 47
No 5.	Japan's Big Fishing Companies	13 Mar 47
No 6.	Japanese Food Collection Program with Emphasis on Collection of the 1946 Rice Crop	11 Mar 47
No 7.	Garnet Resources of Japan	1 Apr 47
No 8.	Consumption of Expendable Materials by Japanese Coal Mines	1 May 47
No 9.	Radio-Grade Quartz Crystal Resources in Japan	10 May 47
No 10.	Japanese Oyster Seed Export Program for 1947	3 Jun 47
No 11.	Newsprint in Japan	6 Jun 47
No 12.	Experimental Smelting and Refining of Iron-Chromium-Nickel Ore in Japan	12 Jun 47
No 13.	1947 Summer Grain Collection and Related Problems	19 Jul 47
No 14.	Machinery Distribution in the Japanese Mineral Industry	19 Jul 47
No 15.	Pyrophyllite Resources in Japan	19 Aug 47
No 16.	The Briquette Industry in Japan in 1947	24 Sep 47
No 17.	Material Consumption in the Japanese Mining Industry	27 Sep 47
No 18.	Collection of 1947 Fall Crops in Japan	22 Nov 47
No 19.	Sources of Coal in East Asia	10 Dec 47
No 20.	Machinery Distribution in the Japanese Coal Mining Industry	17 Dec 47
No 21.	The Coated Paper Industry of Japan	17 Mar 48
No 22.	Utilization of Methane as Fuel in Japan	7 Apr 48
No 23.	The Cigarette Paper Industry of Japan	28 Apr 48
No 24.	Japanese Sponge Culture Experiments in the South Pacific Islands	5 May 48
No 25.	Outlook for Japanese Agriculture	6 May 48
No 26.	Sources of Bauxite in Asia	1 Jun 48
No 27.	Japanese Government Forestry Research, 1947	9 Jun 48
No 28.	Japanese Wildlife Sanctuaries and Public Hunting Grounds, 1948	18 Sep 48
No 29.	Japanese Antarctic Whaling Expedition, 1947-48	2 Oct 48
No 30.	Talc Resources in Japan	14 Oct 48
No 31.	Fisheries Cooperatives of Japan	13 Jan 49
No 32.	Materials and Power Used in Nonferrous Smelting and Refining in Japan	26 Mar 49
No 33.	Forest Fuel Production in Japan	12 Jul 49
No 34.	Japanese Antarctic Whaling Expedition, 1948-49	31 Oct 49
No 35.	Electric Furnace for Smelting Low-Grade Ores in Japan	18 Nov 49
No 36.	Development of Agricultural Cooperatives in Japan	24 Feb 50
No 37.	Forest Area, Volume, and Growth in Japan	12 May 50
No 38.	Japanese Fishing Fleet Statistics, 1948	16 May 50
No 39.	Forestry and Flood Control in Japan	Jul 50
No 40.	Japanese Forestry Bibliography, 1940-48	Aug 50
No 41.	Japanese Antarctic Whaling Expedition, 1949-50	Oct 50

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REPORT NUMBER 139
January 1951

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