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SUPREME COMMANDER FOR THE ALLIED POWERS
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FIRE CLAY RESOURCES OF JAPAN

by

Donald E. Lee

GENERAL HEADQUARTERS
SUPREME COMMANDER FOR THE ALLIED POWERS
Natural Resources Section

NATURAL RESOURCES SECTION
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FIRE CLAY RESOURCES OF JAPAN

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Distribution

NATURAL RESOURCES SECTION
REPORT NUMBER 130
July 1950

FIRE CLAY RESOURCES OF JAPAN

by
Donald E. Lee 1/

SUMMARY

1. Japan's major deposits of clay, in Aichi and Gifu prefectures, have resulted from the weathering of granitic intrusives. This clay has been used for the manufacture of pottery for almost 800 years and was the first clay in Japan to be used in the field of refractories about 100 years ago. Domestic clays subsequently brought into production for refractory purposes, listed with the first date of use in quantity, include: Joban district clay, Fukushima Prefecture, 1908; clay from Mie Prefecture, 1915; the Iizuka district clay, Fukuoka Prefecture, 1930; and the Iwate clay from Iwate Prefecture, 1937.

2. Although Japan has always been able to satisfy its needs for a plastic-type fire clay from the Gifu and Aichi deposits, workable reserves of good flint-type fire clays in Japan are inadequate. As a result, more than 3,000,000 metric tons of high-aluminum shale were imported from Manchuria, Korea, and China during 1930-44 to satisfy the needs of the rapidly expanding Japanese industry. These shales were mixed with plastic-type clays of Aichi and Gifu prefectures for the manufacture of high-grade refractory bricks.

3. Beginning about 1939, special efforts were made to develop the best domestic deposit of flint-type fire clay, the Iwate clay of Iwate Prefecture. During the war and under the management of Nittetsu Kogyo Kabushiki Kaisha, production of the Iwate clay exceeded 10,000 tons a month. Since 1945, however, managerial and transportation difficulties at the Iwate mine have led to efforts to supplement the Iwate production with similar domestic clays from other localities. The development of the clay in the Chikubetsu area of Hokkaido has been precluded by technical difficulties of extraction. Another prospect, the Yoshioka area of Hokkaido, possesses clay of less uniform qualities than the Iwate clay and would require a large investment before a substantial production could be obtained. However, further exploration and large-scale development of the Yoshioka clay may result if future demand is sufficient.

4. Large reserves of plastic-type fire clay in Aichi and Gifu assure Japan of an adequate supply of this clay for many years, but domestic flint-type clays continue in short supply. Present conditions indicate that every effort should be made to exploit the estimated 20,000,000 metric tons of Iwate refractory clay reserves, although future availability of north China or Manchurian shale in quantity probably would throttle Iwate production.

1/ This report was prepared by Mr Donald E. Lee, scientific consultant, Mining and Geology Division. Special acknowledgment is due to the following members of the Mining and Geology Division: Mr Paul O. Elmquist, former scientific consultant, now of the United States Geological Survey, for valuable preliminary work; Mr Hideshiro Hasegawa, scientific consultant, for assistance as interpreter and adviser during field trips; Mr Tadashi Naito and Miss Suzuko Kaku for translating and compiling data; Mr Melvin Pollard for editorial assistance.

5. Closely associated with, and of the same origin as, the fire clays of Aichi and Gifu are large reserves of a ball clay which is widely used in the whiteware manufacturing industry of Japan. About 92 mines in the area produce fire clay or ball clay, or both. The great majority of these mines are worked by hand methods as small-scale open pit operations. The largest mines, however, are efficiently run and possess some mechanization.

6. Open pit and underground methods are used to exploit the domestic flint-type fire clays, all of which are associated with Tertiary coal seams.

INTRODUCTION

1. Scope of Report

Fire clays of sedimentary origin are much more important commercially than residual clays. Sedimentary fire clays are of two main types: plastic fire clays and flint clays. Plastic fire clays are easily molded when moist and may approach the ball clay classification. Flint clays are hard and dense, with a conchoidal fracture; they are less plastic and usually more refractory than plastic fire clays. The most desirable clay materials usually include a mixture of these two types of fire clay.

In Japan, the flint clays are fairly easily defined, but the plastic-type fire clays present a more difficult problem in classification and nomenclature. The greatest concentration of clay deposits in Japan, the transported weathering products of a great granite batholith, occurs in Aichi and Gifu prefectures. Most of the deposits of this area are plastic-type clays known to the Japanese as "kibushi" and "gaerome". The literal translation of gaerome is "frogs' eyes", a term which refers to the numerous quartz crystals present in this clay. These crystals are easily washed from the body of the clay, leaving a good ball clay which is widely used, chiefly in the whiteware industry but also as a refractory. Kibushi is translated as "wood-knot", referring to the thin seams and numerous particles of lignite associated with the clay. Although kibushi also is a ball-type clay, it is used mostly as a fire clay or as a refractory bond clay; in this report it is considered a plastic-type fire clay. Kibushi and gaerome very often occur together, being separated by sharp or gradational contacts. The mines may produce gaerome, kibushi, or both. In some instances distinguishing between the two types of clay is difficult, and they are mined together without separation.

Thus the general term "fire clay", indefinite at best, must be defined even more arbitrarily in Japan than in most places. As gaerome is a ball clay used primarily in the whiteware industry and only secondarily as a refractory clay, it might be discussed more appropriately in a report on the whiteware raw material resources of Japan. However, to simplify treatment and to avoid repetition, this report on Japan's resources of fire clay will include not only flint and plastic fire clays but also gaerome or ball clay. Residual fire clays are not discussed, as Japan has no deposits of commercial value. Additional Natural Resources Section reports on whiteware raw materials and on bentonite and bleaching clay resources of Japan are being prepared.

2. Terminology

The term "fire clay" has a general connotation but no standardized definition. The difficulties of arbitrary usage have been aggravated by qualifications such as No 1 or No 2, and high- or low-grade. These classifications sometimes are inconsistent even within a given district.

Refractoriness is the prime requisite for any true fire clay, and probably no clay with a fusion point below 1600°C should be so designated. The refractoriness of a clay is determined by its composition and texture. In addition to high temperature of fusion, various other properties are demanded for individual uses; these include plasticity, shrinkage, transverse strength, density, and color. The best result for a given use usually can be achieved by a mixture of clays.

In the ceramic industry the fusion point of a clay or a mixture of clays is given in terms of Seger Cones (abbreviated SK). These cone-shaped test-pieces are about 1 1/2 inches high and consist of mixtures representing a series of fusion points. The highest SK number, 42, corresponds to a temperature of 2015°C. Fusion temperatures as low as 585°C can be measured by means of these cones. In this report the fusion points of clays will be given in terms of SK numbers, with the corresponding centigrade temperatures in parentheses.

Clays associated with coal beds are sometimes highly refractory, but not consistently so; the term "fire clay" should not be reserved for clays of such occurrence, although this limitation has been a common misuse of the term in the past.

3. Sources of Information

The information contained in this report has been drawn from many sources. Inconsistent and conflicting data have been received, and the selection of certain data as the most reliable and representative sometimes has had to be rather arbitrary. Clays never have been included in the Japanese Mining Law, so even such little impetus for gathering and organization of statistics as is manifest in the Japanese mining industry generally, is absent where the production of clays is concerned. However, despite uncertainties concerning past data, available information on present supply and estimates for the future is consistent and reliable.

More than 40 producing mines were visited by the author. Brief reconnaissance surveys were made, and mine managers were interviewed. A standardized questionnaire was submitted to all present producers. However, misinterpretation of questions, ambiguity of answers, and other language difficulties made the returns disappointing. Much information and advice were received from the Mining Bureau, Ministry of International Trade and Industry, and the Japanese Geological Survey. Mr T. Oshima of the Mining Bureau was particularly helpful. Valuable information also was obtained from the various fire clay producing associations in Japan.

Because of the difficulties and delays involved in collecting data, no attempt was made to incorporate production and cost data later than 1948, as investigations already completed indicated that later data would not cause any significant change in the general picture of the industry.

GENERAL

1. History

The extensive kibushi and gaerome deposits of Aichi and Gifu prefectures have been used for the manufacture of pottery for almost 800 years. Today these clay deposits have made Nagoya the center of Japan's important ceramic industry. Although many home-type factories still produce pottery from locally procured materials, chief production is by the larger factories which manufacture whiteware from gaerome, kibushi, china stone, kaolin, quartz, and feldspar.

Kibushi from the Seto area in Aichi Prefecture was the first clay to be used for the manufacture of refractories in Japan, about 100 years ago. It still satisfies Japan's needs for a good plastic-type fire clay, and present reserves promise an adequate supply for many years.

The Joban district of Fukushima Prefecture began producing fire clay about 1908. During World War I Japan's rapidly expanding industry began to seek more highly refractory clays to mix with the plastic fire clays of the Seto area for the manufacture of high-grade fire bricks. In 1915 production of a clay similar in occurrence and qualities to that of the Seto area was begun in Mie Prefecture. In 1930 production commenced in the Iizuka area of Fukuoka Prefecture, and use of the high-quality clay from Iwate Prefecture began in 1937.

Although each of these domestic clays has been used continuously since its discovery, after 1930 Japan's demand for a highly refractory clay was supplied principally by imports until they were cut off during World War II. More than 3,000,000 metric tons 2/ of high-aluminum shale were imported from Posan, Shantung province, China, the Liaoyang area of Manchuria, and the Heijo area of north Korea during 1930-44. These shales were mixed with plastic-type clays for the manufacture of high-grade refractory bricks.

The best domestic substitute for these high-aluminum shales is the Iwate clay. Under wartime pressure, production of this flint-type clay exceeded 10,000 tons a month, but since August 1945, managerial and transportation difficulties have caused an increasingly critical shortage of this high-quality clay. Consistent efforts to supplement the Iwate production effectively with other domestic clays of a similar type have been unsuccessful. Use of the Chikubetsu clay from northwest Hokkaido has been precluded by technical difficulties of extraction. The Yoshioka clay in southwest Hokkaido may be a future prospect, but it has nonuniform qualities and its development would require a large initial investment.

2. Production and Consumption

Such data as exist on past production of plastic fire clays in Japan are often inconsistent, especially for the many small producers in Aichi and Gifu prefectures. Because a substantial quantity of these clays has been used for the production of pottery, the best data available for 1925-44 are estimates by the Ceramic Section, Chemical Bureau, Ministry of International Trade and Industry, based on the known amount of finished clay products for these years. Available plastic fire clay production figures for the years before 1945 are very incomplete; the totals in reported data are only 20-30 percent of the Chemical Bureau estimates. Production data submitted by individual mine owners are used for the 1945-47 totals, and 1948 totals are from the Mining Bureau, Ministry of International Trade and Industry (Table 1).

For flint-type fire clays, the totals of available past production data from individual mine records are the most reliable and representative information available for 1925-48 (Table 1).

Imports of high-aluminum shale (Table 2) played an important part in the Japanese firebrick industry during 1930-44. Scattered stockpiles of high-aluminum shale imports were used through 1948, but these are almost exhausted.

Apparent Japanese consumption of fire clays and high-aluminum shale for the years 1925-48 is summarized:

TABLE A. - APPARENT CONSUMPTION OF FIRE CLAYS AND HIGH-ALUMINUM SHALE, 1925-48
(metric tons)

Year	Total Production of Fire Clay	Total Imports of Shale	Total Apparent Consumption
1925	108,500	0	108,500
1926	109,500	0	109,500
1927	110,000	0	110,000
1928	120,348	0	120,348
1929	136,237	0	136,237

(Cont'd)

2/ See Glossary for conversion from metric to English units of measurement.

TABLE A. - APPARENT CONSUMPTION OF FIRE CLAYS AND HIGH-ALUMINUM SHALE, 1925-48 (Cont'd)
(metric tons)

Year	Total Production of Fire Clay	Total Imports of Shale	Total Apparent Consumption
1930	148,400	37,156	185,556
1931	147,782	23,173	170,955
1932	255,295	43,344	298,639
1933	369,680	85,106	454,786
1934	378,820	107,186	486,006
1935	389,140	136,206	525,346
1936	390,273	153,598	543,671
1937	383,666	204,736	588,402
1938	473,743	331,209	804,952
1939	638,617	363,275	1,001,892
1940	582,494	364,862	947,356
1941	698,342	319,800	1,018,142
1942	609,412	317,458	926,870
1943	634,289	279,471	913,760
1944	569,270	327,344	896,614
1945	201,450	0	201,450
1946	122,265	0	122,265
1947	178,299	0	178,299
1948	239,302	0	239,302
TOTAL	7,995,124	3,093,724	11,088,848

Japanese ball clay requirements have been satisfied entirely by domestic production, mostly from the many small mines in Aichi and Gifu prefectures. Again, estimates by the Ceramic Section, Chemical Bureau, based on statistics on output of wares which require ball clay as raw material, are used for the years before 1945. Data submitted by individual mine owners are used for 1945-47, and 1948 data were obtained from the Mining Bureau.

TABLE B. - PRODUCTION OF BALL CLAY (GAEROME), 1930-48
(metric tons)

Year	Amount	Year	Amount
1930	502,777	1940	545,000
1931	501,111	1941	515,000
1932	547,000	1942	177,000
1933	542,000	1943	172,000
1934	648,000	1944	116,000
1935	487,000	1945	79,507
1936	504,000	1946	60,246
1937	446,000	1947	103,163
1938	467,000	1948	157,286
1939	442,000	TOTAL	7,012,090

Ball clay production data cited are in terms of raw clay. About one-half of the present production is washed to obtain a high-grade material for use in the manufacture of whiteware for export. The remainder is used without washing for the production of locally consumed wares and of refractories. Details of the washing process are described in the section of this report which discusses Aichi and Gifu prefectures.

In general, most of the gaerome is used as a ball clay in the whiteware industry, but small amounts are used for refractory purposes. Most of the kibushi is used as a plastic-type fire clay, but substantial quantities have been used as a ball clay in the manufacture of sanitary ware and electrical porcelain.

3. Anticipated Future Production

Large reserves in the Aichi-Gifu area assure Japan an adequate supply of ball clay and plastic-type fire clay for many years. Intensity of demand will dictate the practicability of working some deposits where thick overburdens make operations uneconomic during the time of a strong buyers' market.

However, Japan will continue to have difficulty in supplying its flint-type fire clay needs domestically. In the absence of imports of shale from China and Manchuria, Japan will look to the estimated 20,000,000 tons of Iwate refractory clay reserves for this type of clay. However, production and shipments of the Iwate clay will have to be substantially higher than the 1946-49 levels if they are to satisfy the needs of Japanese industry. In spite of its disadvantages, further exploration and development of the Yoshioka clay may become necessary in the future.

Production of all types of clay in Japan is hindered by the fact that clay is not included in the Japanese Mining Law. The situation which has confronted the operators of the Iwate mine is a case in point. The Iwate mine was originally started as a coal producer in 1936. Because coal is included in the Japanese Mining Law, the company was required to stake mining claims to cover the area it intended to work but was not required to purchase the land. Mining by underground methods was begun. About a year later the refractory qualities of the clay associated with the coal were discovered, and clay production became the main business of the mine. However, because clay is not included in the Japanese Mining Law, the claims were worthless to a clay producer, and the company had to purchase the land covered by the claims. Because some of the surface above the mine workings was used for agriculture, after the enactment of the Land Reform Law in 1946 the Tokyo location of the company's main office was interpreted as absentee land ownership, and the land thus became subject to immediate purchase for land reform purposes. To maintain production of the badly needed fire clay, the Ministry of Agriculture and Forestry had to modify implementation of the Land Reform Law in the area of the mine with stipulations which allow the company to maintain ownership of the land underlain by the clays.

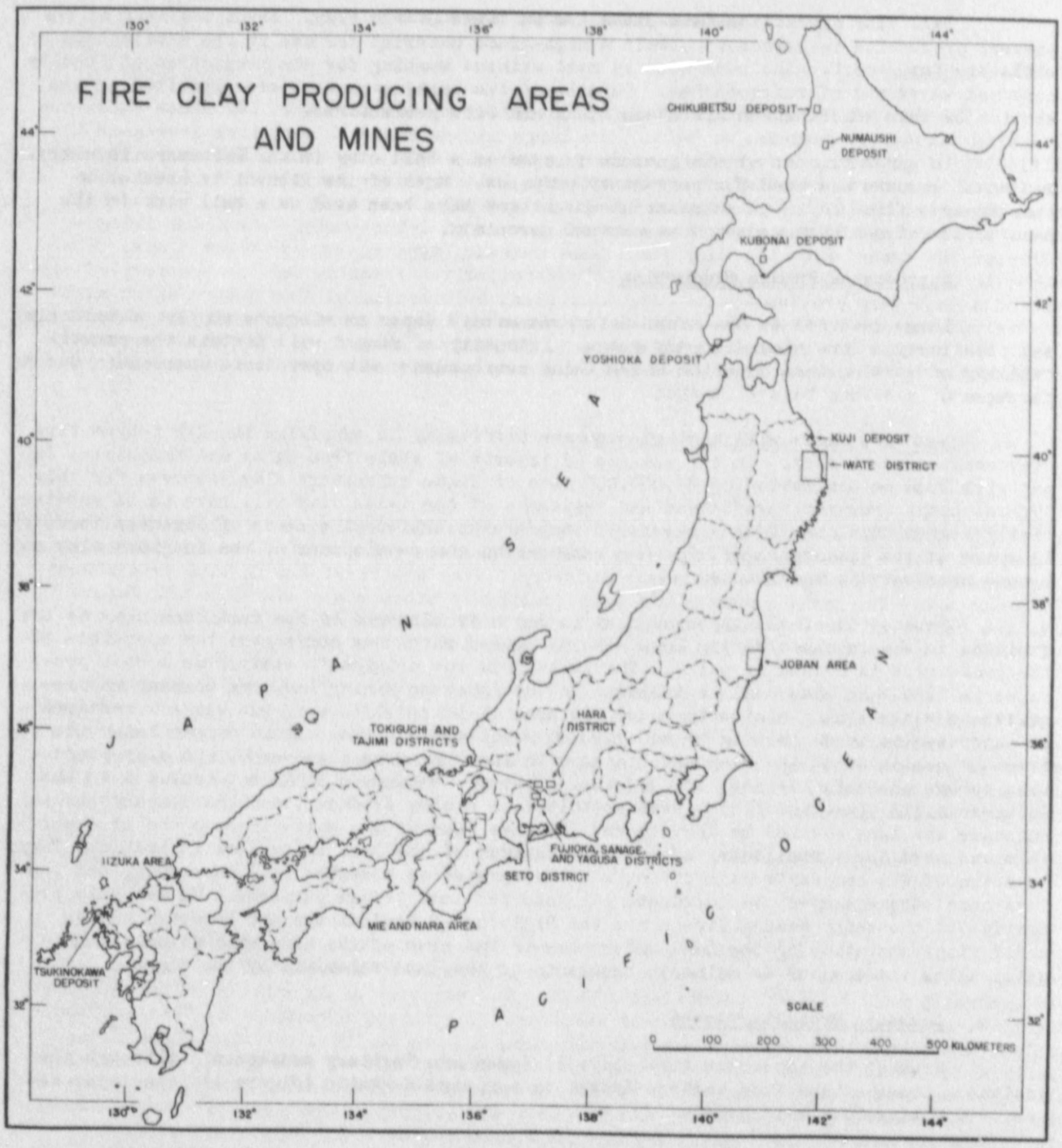
4. Domestic Producing Areas

Most of the important fire clays of Japan are Tertiary sediments. Although the producing mines extend from western Kyushu to northern Hokkaido (Figure 1), the major deposits comprise four main groups:

a. Northwestern Kyushu
   - Iizuka area
   - Tsukinokawa deposit

b. Central Honshu
   - Aichi and Gifu prefectures
   - Mie and Nara prefectures

c. Northeastern Honshu
   - Joban area
   - Iwate deposit
   - Kuji deposit



NATURAL RESOURCES SECTION

Figure 1

d. Western Hokkaido
   Yoshioka deposit
   Chikubetsu deposit
   Numaushi deposit
   Kubonai deposit

In the detailed descriptions of individual areas and mines which follow, these groups will be considered in the order of their importance: central Honshu, northeastern Honshu, northwestern Kyushu, and western Hokkaido.

CENTRAL HONSHU AREAS AND MINES

1. General

The central Honshu group of clay producers includes more than 120 mines which are producing kibushi or gaerome, or both. The large number of small operators increases the difficulty of gathering information concerning the mines in this area. Not only are clay statistics in general unsatisfactory because the industry does not keep or collect data on an organized basis, but production itself is sporadic because of the wide horizontal extent of the clays in the area, the seasonal nature of labor employed, and the irregularity of the demand from the many small home workshop-type consumers of the clays. The gathering of past production statistics is particularly difficult, and the accuracy of any such data is highly problematical. Any additional information of this nature which might be obtained through further investigation of mines no longer operating would not materially affect the conclusions reached in this report. Therefore only those clay mines presently in operation in this area, from which data are more readily obtained, are considered in this report.

2. Mines of Aichi and Gifu Prefectures

a. General

The 92 clay mines operating in Aichi and Gifu prefectures furnish more than 90 percent of the plastic-type fire clay used in Japanese refractories and all the ball clay consumed by the Japanese whiteware industry. Clay was first dug in this area almost 800 years ago. The great quantity and good quality of these clays have made the Nagoya area the center of the Japanese ceramic industry, and reserves of good quality clay are sufficient to enable the area to maintain this position in the future.

Present production, however, is curtailed by several factors, including transportation difficulties and the exclusion of clay from the Japanese Mining Law, which handicaps all producers of clay in Japan. In addition, some producers find it difficult to reconcile present ceiling prices of clay with production costs, and work is hampered by shortages of materials, notably the canvas cloth which is used in filter presses for the drying of washed gaerome.

b. Geologic Features

(1) General

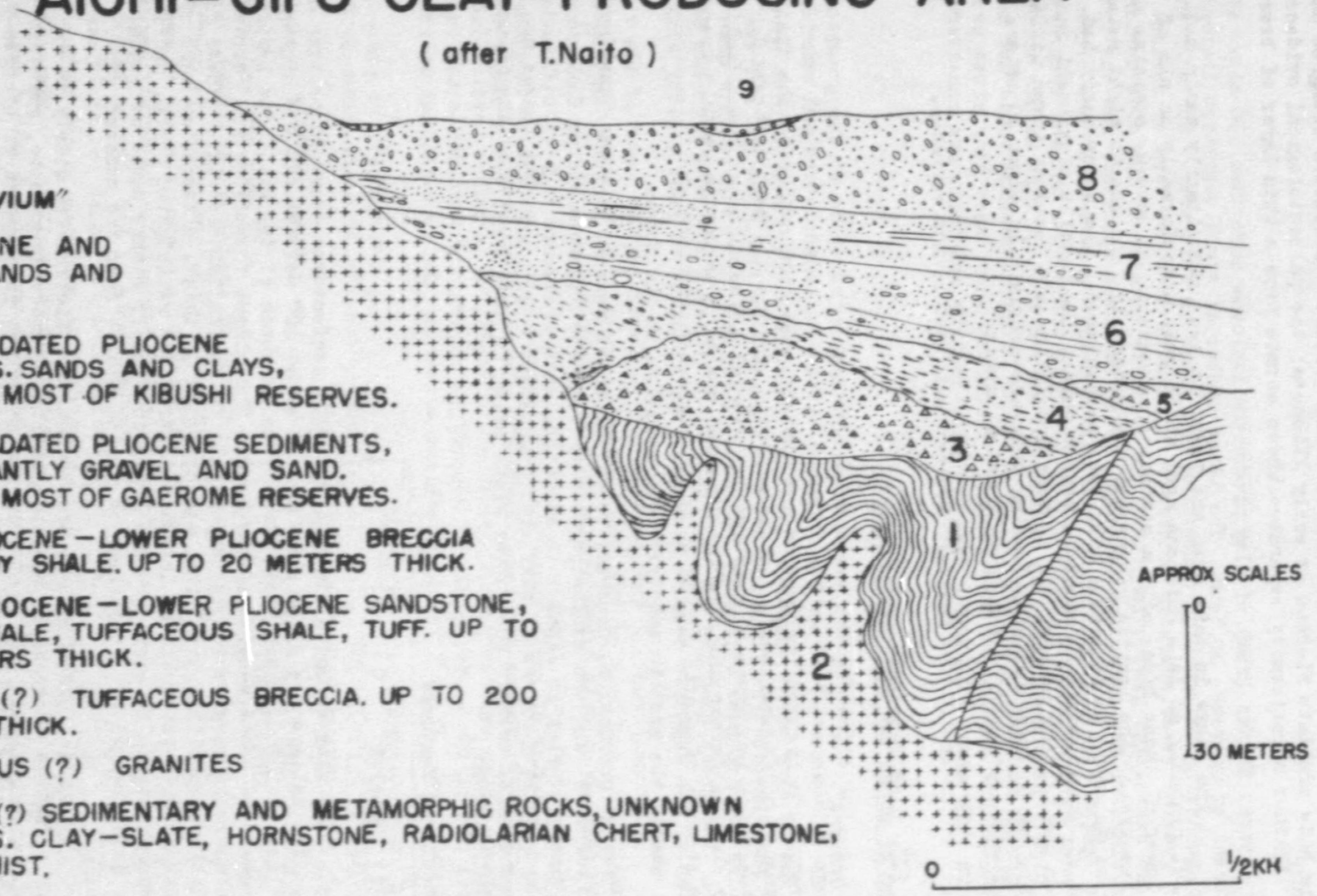
The clay deposits of Aichi and Gifu prefectures occur in an area of low, rolling hills. The valleys are at an elevation of about 100 meters, and the highest hills are generally less than 600 meters above them. The sequence of deposition is indicated in Figure 2, an idealized cross section of the area. The oldest formations are Permian sedimentary and metamorphic rocks which outcrop mainly in the Tajimi district. These formations, which exhibit complicated folding, are composed of thick, alternating beds of clay slate and sandstone with intercalated layers of quartzite, radiolarian chert, and limestone. The general strike is east, and the beds dip steeply either north or south. Granitic intrusives have changed the formations to a mica schist near the contact zone.

Granites, probably late Cretaceous, are distributed widely in and around the area. Four varieties of granite, biotite-granite, hornblende-granite, granodiorite, and pegmatites, are recognized. The center of the batholith is composed of biotite-granite; the margins are hornblende-granite. An elongated stock of granodiorite cuts both the biotite-granite and the hornblende-granite. Small pegmatite dikes cut all the other granites. The hornblende-granite is schistose near the contact with Permian rocks.

An andesitic tuffaceous breccia, thought to be of Miocene age, is unconformable on the granites and the Permian rocks. The breccia includes small amounts of fragmental quartzite and clay-slate and is cemented by a tuffaceous sand. The bed is thought to have a maximum thickness of about 200 meters, but only small, scattered outcrops are seen.

IDEALIZED GEOLOGIC CROSS SECTION OF THE AICHI–GIFU CLAY–PRODUCING AREA

(after T.Naito)



9 RECENT ALLUVIUM AND "DILUVIUM"

8 PLEISTOCENE AND RECENT SANDS AND GRAVELS

7 UNCONSOLIDATED PLIOCENE SEDIMENTS. SANDS AND CLAYS, INCLUDING MOST OF KIBUSHI RESERVES.

6 UNCONSOLIDATED PLIOCENE SEDIMENTS, PREDOMINANTLY GRAVEL AND SAND. CONTAINS MOST OF GAEROME RESERVES.

5 UPPER MIOCENE–LOWER PLIOCENE BRECCIA AND SANDY SHALE. UP TO 20 METERS THICK.

4 UPPER MIOCENE–LOWER PLIOCENE SANDSTONE, SANDY SHALE, TUFFACEOUS SHALE, TUFF. UP TO 25 METERS THICK.

3 MIOCENE (?) TUFFACEOUS BRECCIA. UP TO 200 METERS THICK.

2 CRETACEOUS (?) GRANITES

1 PERMIAN (?) SEDIMENTARY AND METAMORPHIC ROCKS, UNKNOWN THICKNESS. CLAY–SLATE, HORNSTONE, RADIOLARIAN CHERT, LIMESTONE, MICA–SCHIST.

NATURAL RESOURCES SECTION

Figure 2

Unconformable on the breccia is a series of sandstone, tuffaceous shale, and tuff beds with a maximum thickness of about 25 meters. Geologists disagree as to whether these beds are late Miocene or early Pliocene; the paleontological evidence is not convincing. Another unconformity separates these strata from a thin layer of breccia and sandy shale.

The clays in this area are found in two predominantly sandy beds (6 and 7 in Figure 2), probably of late Pliocene age, which rest unconformably on all of the older rocks. The lower of these beds, with a maximum thickness of 20 meters, contains most of the gaerome reserves. The lentils of gaerome are generally from one to eight meters thick, but thicknesses as great as 12 meters have been encountered. The upper sandy bed, which contains most of the kibushi, is about 10 meters thick; the lentils of kibushi range in thickness from one to four meters, and in some localities are found at three different horizons within the bed. These two clay-bearing beds are overlain by about 20 meters of unconsolidated Pleistocene and recent gravels and alluvium.

The dip of the Tertiary sediments is gentle and variable.

(2) Clay Deposits

The clays are the transported weathering products of the granites in the area. Although this report follows the Japanese system of nomenclature and considers separately the production figures for gaerome and kibushi, the distinction in the field sometimes seems vague and inconsistent. In the author's opinion the best criteria for differentiating between the two types of clay are the general association of the kibushi with lignite seams and its darker color in the unburned state. Gaerome is usually associated with variable amounts of quartz grains up to a centimeter in diameter.

Although most of the gaerome clay is found in the lower of the two predominantly sandy beds, and most of the kibushi in the upper, the thickness, quality, and stratigraphic position of both types change rapidly laterally.

Remains of marsh trees and water plants with floating leaves are found in the clays, but marsh grasses are not. Hence the places of deposition are thought to have been lowlands which were subject to constant fluctuations of water level. Judging from the fossil plants, the environments of deposition apparently were protected from direct sea winds and currents. Figure 3 is an idealized sketch of the depositional environment.

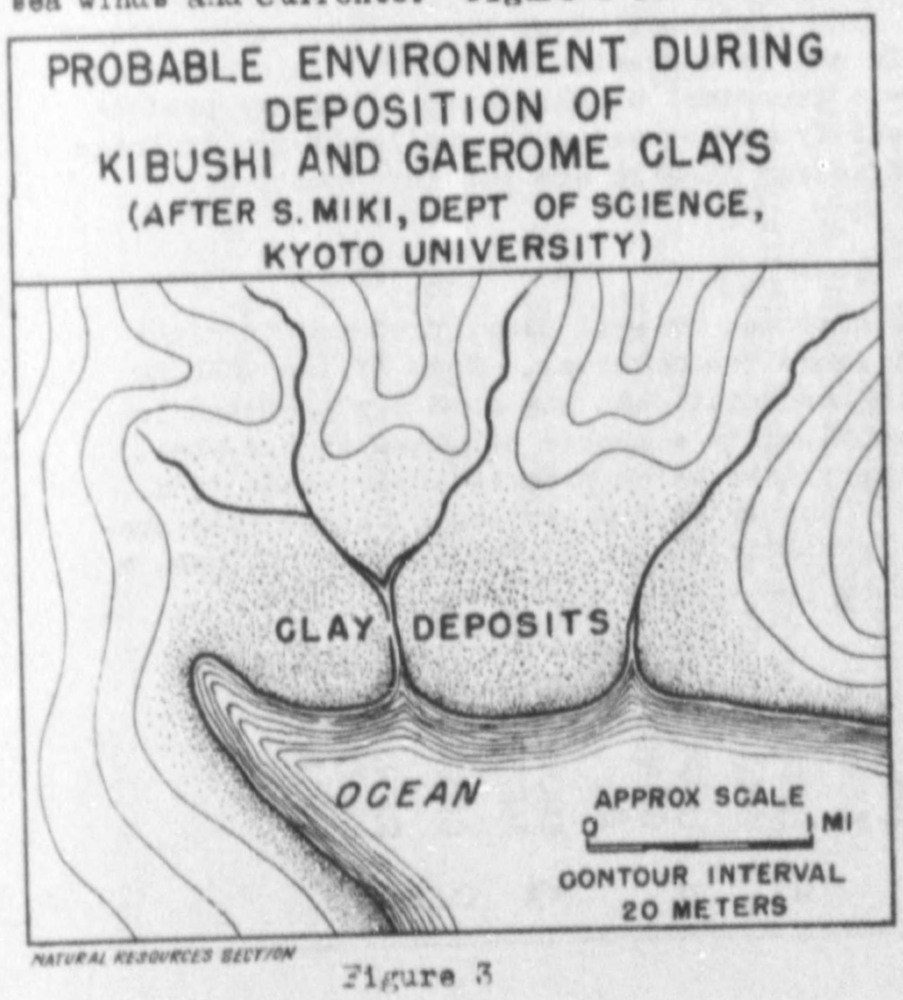


Figure 3

Representative analyses of clays from the area are shown in Table 3.

c. Mining Methods

Both open pit and underground methods of mining are employed. Underground methods generally are confined to kibushi pits where recovery of associated lignite seams helps to defray higher mining costs. Some of the lignite is made into briquettes for local household use; the remainder is employed in the baking of local porcelain and pottery. Gopher-holing is the usual underground method employed, but occasionally a room-and-pillar practice is approached.

Most of the mines are worked as open pits. When Korean laborers were available, mines could be worked economically with an overburden-workable clay ratio of six to one. At present the limit of this ratio is four or five to one. Both men and women are employed as laborers.

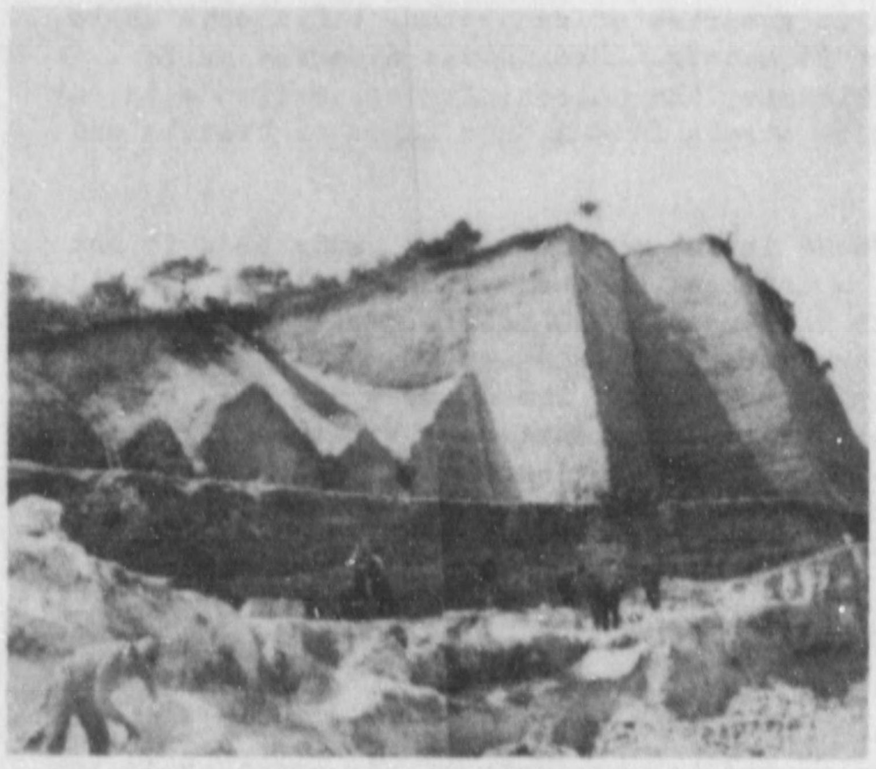


Figure 4. - Overburden stripping at the Yamanouchi mine. Characteristic cross-bedding of water-deposited sediments of the area is visible on the smooth cuts. The men are standing on a bed of gaerome. Fujioka-mura, Nishikamo-gun, Aichi Prefecture, April 1948.

mostly on a daily wage basis. Contract laborers employed for overburden removal are paid by the volume of overburden removed. Cuts dug by contractors occasionally are remarkable for their regular faces and angular turns, made for ease of volume computations (Figure 4).

Pick and shovel methods are used in almost all workings. The Fujioka mine, a notable exception, employs jackhammers. Steam shovels are not used at all. Transportation from the mines is by truck and horse cart. Considering the mechanization and labor available, the larger open pits are efficiently laid out and operated (Figure 5). Gravity loading methods are employed in overburden stripping at some of the larger workings, the overburden being caved into cars which run on tracks at the base of the cut. Where the mine lots are small, juxtaposition of several often poses an overburden removal problem, and inefficient stripping practices result.

d. Mining Costs

Although representative mining cost data are available for most of the producing districts of Gifu and Aichi prefectures (Table 4), these data do not lend themselves to any standard, detailed analysis because of the variety of breakdowns on questionnaire returns. However, where the costs in one district are consistently different from those in another, the difference usually is traceable to some special problem such as drainage or overburden removal.

No general conclusions can be drawn as to the relationship of production costs to the size of the mine or the type of clay produced. Even the relationship between production per employee and production cost is not consistent. Overburden thickness, as in the Sanage and Yagusa districts, is the most important single cause of higher production costs. Other factors, not always apparent from the cost data available, are drainage problems, excessive office expenses, and inefficient digging and loading practices.

e. Washing Plants

At present about one-half of the gaerome, or ball clay, produced in Aichi and Gifu prefectures is washed for use as whiteware raw material. Some of the washing plants are owned and operated by clay-producing associations, and some are operated independently. In both cases the raw clay is supplied by a number of mines in the area. Some of the larger mines have their own washing plants which process their production. No attempt is made here to trace the sources of supply of the various plants or the consumers of their output. The 27 gaerome washing plants in the two prefectures shipped a total of 27,535 metric tons of washed gaerome in 1948 (Table 5).

Figure 5. - Layout of the Mifune kibushi mine. Thin beds of lignite are visible on the right side of the lowest stratum exposed in the cut. This scene illustrates the conflict between agricultural and clay-mining operations which is typical of this area. Sanage-mura, Nishikamo-gun, Aichi Prefecture, April 1948.

The washing process is more or less standard in the larger plants. Crude gaerome containing impurities such as quartz grains, mica flakes, and specks of pyrite is dumped into cylinders about 1.2 meters in diameter and 3.7 meters high. The cylinders are lined with granite blocks. The agitator, consisting of three or four blades mounted on a drive in the center of the cylinder, rotates at about 30 revolutions per minute. About 20 kilograms each of water and crude gaerome are dumped into this stirring tank every minute. In some plants about one gram of caustic soda is mixed with each ton of water to promote flocculation. Sand and pyrite washed from the clay settle in the bottom of the stirring tank and are removed periodically. The overflow runs off through a length of settling troughs into settling tanks.

Generally the speed of the overflow in the settling troughs is controlled more by the volume of overflow than by the inclination of the troughs. The troughs are usually about 15 centimeters wide, 35 centimeters deep, and 30 meters long. A stop 30 centimeters high before the trough empties into the settling tank eliminates the mica, which is carried about halfway between the top and bottom of the stream. The troughs are cleaned of quartz, pyrite, and mica every five houre. Screens and magnetic separators also are used to purify the flow before it is passed into the settling tanks.

When the clay has settled to the bottom of the tanks, the clear water is drained off. The slip which remains is pumped into a filter press for drying. Most of the presses used have about 100 round cast iron chambers. Each chamber is about 75 centimeters in diameter and concave on both sides, with a central hole about eight centimeters in diameter. The chambers are mounted horizontally on a pair of rails with canvas filter cloths between each pair of chambers. The slip is pumped through the central holes under a pressure which forces the water of the slip through the filter cloths and forms a series of 100 clay discs. The discs are then removed for air-drying and shipment to whiteware factories.

The percent of recovery of washed clay from crude varies between 10 and 25, and averages about 20. Sometimes as much as 70 percent of the original clay is recovered as a quartz sand by-product. Amounts of materials recovered and their uses will be discussed in a forthcoming report on the whiteware raw material resources of Japan.

The amount of crude clay treated varies between 0.35 and 1.75 tons per man per day. Washing costs vary between ¥786 and ¥2,892 per ton of washed clay (Table 6).

f. Production

Available data on 1945-48 production of kibushi (plastic-type fire clay) and gaerome (ball clay) by mines in Aichi and Gifu prefectures are summarized:

TABLE C. - PRODUCTION OF KIBUSHI IN AICHI AND GIFU PREFECTURES, 1945-48
(metric tons)

District	1945	1946	1947	1948	Total
Seto	13,620	19,490	14,985	28,741	76,836
Sanage	8,620	8,984	14,871	9,901	42,376
Yagusa	6,697	6,973	8,872	11,055	33,597
Hara	1,736	1,772	3,421	4,533	11,462
Tokiguchi	11,893	18,336	23,980	19,013	73,222
Tajimi	25,299	17,936	45,191	56,500	144,926
TOTAL	67,865	73,491	111,320	129,743	382,419

SOURCE: 1945-47, individual mine owners; 1948, Mining Bureau, Ministry of International Trade and Industry.

TABLE D. - PRODUCTION OF GAEROME IN AICHI AND GIFU PREFECTURES, 1945-48
(metric tons)

District	1945	1946	1947	1948	Total
Seto	2,760	8,380	9,868	22,284	43,292
Fujioka	7,690	8,486	15,412	28,130	59,718
Hara	22,075	15,254	18,360	31,647	87,336
Tokiguchi	33,775	25,547	54,454	70,926	184,702
Tajimi	11,772	1,772	2,797	3,933	20,274
TOTAL	78,072	59,439	100,891	156,920	395,322

SOURCE: 1945-47, individual mine owners; 1948, Mining Bureau, Ministry of International Trade and Industry.

g. Reserves

Although any quantitative statement of clay reserves in the Aichi-Gifu area would be pure speculation, the reserves of both ball clay and plastic-type fire clay are known to amount to millions of tons. No shortage of either type need be expected in the foreseeable future. The extent of future demands for the clays will determine the comparative workability of many deposits where overburden thickness and juxtaposition of agricultural lands create serious problems. Production of gaerome also is limited by washing plant capacities. Additional washing plants are not being built at present, both because a large initial investment is required and because demands of the Japanese porcelain industry are difficult to anticipate.

h. Producing Districts

Seto District: The mines of the Seto district are in Higashi-Kasugai-gun, 3/ Aichi Prefecture, at altitudes of 100-300 meters (Figure 6). They are in grid area 1200-1356, on AMS L571 (Central Japan), scale 1:250,000, Sheet 28 (Iida), and on AMS L774 (Central Honshu), scale 1:50,000, Sheet 5552-IV (Seto).

As indicated in Figure 6, the Seto district may be further divided into four producing localities, Akatsu, Shinano, Mizuno, and Seto proper. Seto proper is the oldest clay-producing locality in Japan, but at present it is not of great importance, producing material only for saggers and domestic tableware. None of the gaerome from Seto proper is washed. The Shinano and Mizuno localities also are very old producers whose present output is used without washing for low-quality ware. The Akatsu locality, however, has two gaerome washing plants in operation and produces about 200 tons of washed gaerome a month. The entire production is consumed by factories in the Nagoya area--20 percent for export chinaware and 80 percent for export tiles. A small amount of lower-grade clay also is produced. The Akatsu locality has prospects for a bright future.

In March 1948, 22 mines were producing in the Seto district with an estimated total of 150 employees, more than 90 percent of whom were male. Available cost and production statistics are summarized in Tables E, F, and 7.

TABLE E. - PRODUCTION OF KIBUSHI BY MINES IN SETO DISTRICT, 1945-48
(metric tons)

Mine	1945	1946	1947	1948	Total
Akatsu (Fujii)	118	2,925	1,697	380	5,120
Daigaku	1,324	904	671	871	3,770
Ichiyanagi	0	0	0	276	276
Kashiba	0	500	500	180	1,180
Kawaji	0	0	0	30	30
Kasen	50	0	0	0	50
Kogumi	0	0	0	5,981	5,981
Maruhachi	ND	ND	ND	1,223	1,223
Maruichi	ND	120	150	1,428	1,698
Marukatsu	141	227	324	446	1,138
Maruni	1,497	234	739	475	2,945
Marutate	397	1,138	1,300	550	3,385
Maruyama	853	ND	ND	750	1,603
Mitsui Mizuno	1,928	1,082	683	428	4,121
Nakashima	ND	ND	ND	20	20
Shinagawa Akatsu	ND	ND	ND	136	136
Shinagawa Shinano	2,137	6,943	4,905	7,596	21,581
Shinano	542	420	205	719	1,886
Toa	960	350	125	266	1,701
Toho (Sangyo)	350	353	422	230	1,355
Tomida	0	0	ND	545	545
Ugai	829	1,958	417	1,202	4,406
TOTAL	11,126	17,154	12,138	23,732	64,150

ND: No data available
SOURCE: 1945-47, individual mine owners; 1948, Mining Bureau.

3/ See glossary for translation of Japanese terms.

TABLE F. - PRODUCTION OF GAEROME BY MINES IN SETO DISTRICT, 1945-48
(metric tons)

Mine	1945	1946	1947	1948	Total
Akatsu (Fujii)	320	5,608	6,942	7,742	20,612
Kawaji	0	0	0	69	69
Kasen	500	818	846	1,509	3,673
Kogumi	0	0	0	11,816	11,816
Marutate	375	553	430	0	1,358
Shinagawa Akatsu	1,070	695	1,200	548	3,513
Shinano	495	706	450	600	2,251
TOTAL	2,760	8,380	9,868	22,284	43,292

SOURCE: 1945-47, individual mine owners; 1948, Mining Bureau.

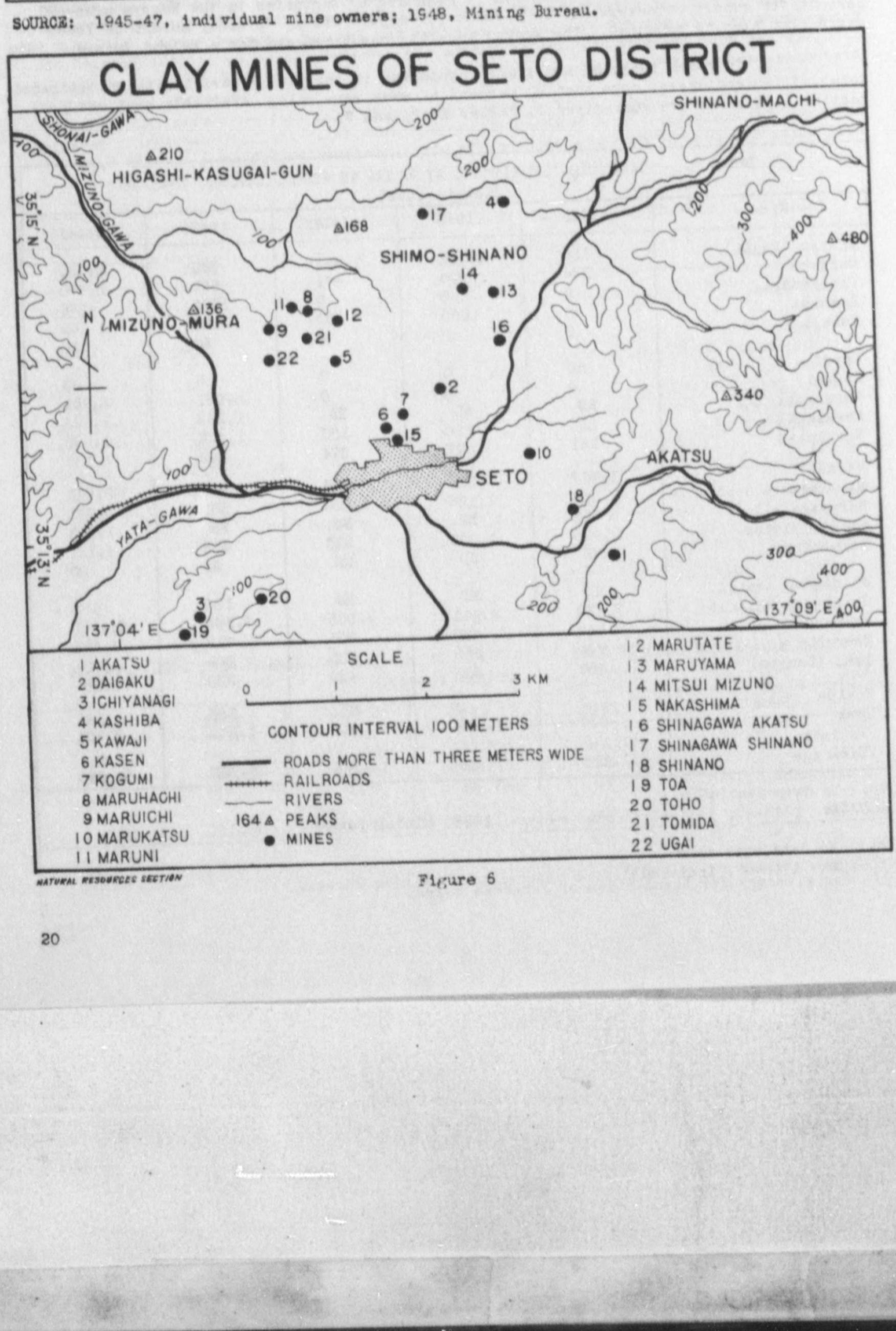


Figure 6

Fujioka and Sanage Districts: The mines of Fujioka and Sanage districts are in Nishi-kamo-gun, Aichi Prefecture, at altitudes of 50-150 meters (Figure 7). They are within the area bounded by grid lines 1216, 1225, 1352, and 1358, on AMS L571 (Central Japan), scale 1:250,000, Sheet 28 (Iida), and on AMS L774 (Central Honshu), scale 1:50,000, Sheets 5552-IV (Seto) and 5552-III (Koromo).

Although the Fujioka and Sanage deposits occur near each other, they produce different types of clay. The pits of Fujioka-mura produce only gaerome. The four washing plants in this area supply raw material to factories in and near Nagoya for the manufacture of export tile, chinaware, and sanitary ware. The clay of Fujioka-mura occurs as a small pocket of alluvial and lacustrine sediments above the Tertiary granite. Reserves are small, and development of the locality is limited.

The best plastic-type fire clays of Japan are found in Sanage-mura. Refractory values range between SK 32 and SK 34 (1700-1760°C), and the clays are used widely for the manufacture of firebricks and crucibles. The small amount of gaerome produced in Sanage-mura is used without washing as material for locally consumed wares. Although this locality has good reserves, future prospects are somewhat dimmed by the thicknesses of overburden encountered.

In March 1948 10 mines were producing in Nishi-kamo-gun with an estimated total of 250 employees, of whom about 80 percent were men. Available cost and production statistics for Fujioka and Sanage districts are summarized in Tables G, H, and 8.

TABLE G. - PRODUCTION OF KIBUSHI BY MINES IN FUJIOKA AND SANAGE DISTRICTS, 1945-48
(metric tons)

Mine	1945	1946	1947	1948	Total
Aichi Nendo	1,268	991	1,409	1,364	5,032
Ejiri	30	300	360	70	760
Hanamoto	952	372	574	100	1,998
Mifune (Nihon Rutsubo)	ND	532	2,025	0	2,557
Mikawa	458	89	0	0	547
Sansei (Mitsuboshi)	4,900	6,700	10,163	7,514	29,277
Tokai Sanage	1,012	0	340	797	2,149
Yamanaga	0	0	0	56	56
TOTAL	8,620	8,984	14,871	9,901	42,376

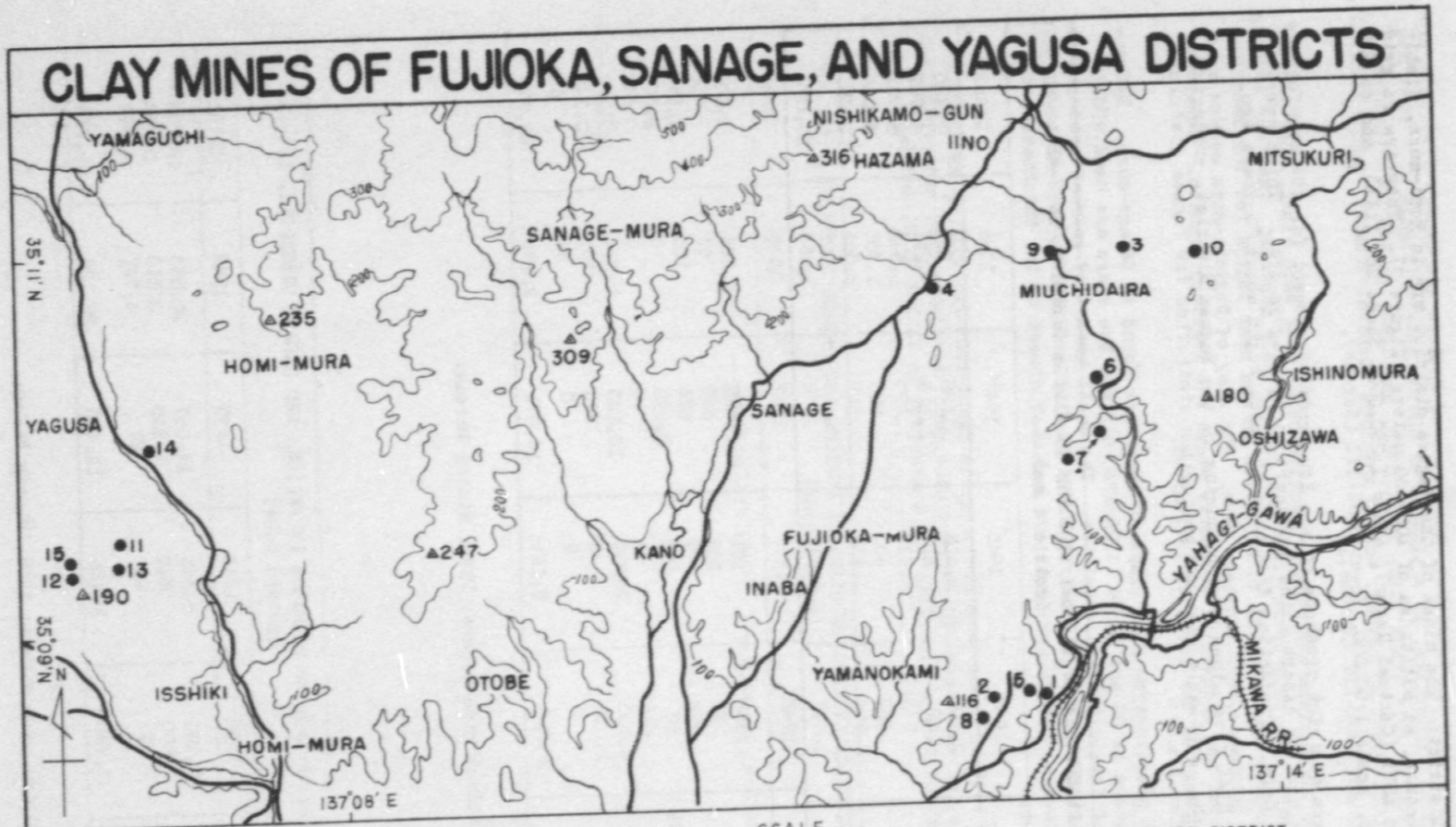
ND: No data available
SOURCE: 1945-47, individual mine owners; 1948, Mining Bureau.

TABLE H. - PRODUCTION OF GAEROME BY MINES IN FUJIOKA AND SANAGE DISTRICTS, 1945-48
(metric tons)

Mine	1945	1946	1947	1948	Total
Fujioka	7,190	7,643	14,067	20,853	49,753
Yamanaga	500	843	1,345	2,510	5,198
Yamanouchi	ND	ND	ND	4,767	4,767
TOTAL	7,690	8,486	15,412	28,130	59,718

ND: No data available
SOURCE: 1945-47, individual mine owners; 1948, Mining Bureau.

CLAY MINES OF FUJIOKA, SANAGE, AND YAGUSA DISTRICTS



NATURAL RESOURCES SECTION

Figure 7

Yagusa District: The mines of the Yagusa district are in Homi-mura, Nishikamo-gun, Aichi Prefecture, at altitudes of 100-160 meters (Figure 7). They are in grid area 1200-1352 on AMS L571 (Central Japan), scale 1:250,000, Sheet 28 (Iida), and on AMS L774 (Central Honshu), scale 1:50,000, Sheet 5552-III (Koromo).

The Yagusa district produces only a low grade of kibushi for the manufacture of saggers, which are used by export china producers in the Nagoya area. Thick overburdens are a problem here. Production from this district began about 25 years ago.

In March 1948 five mines were producing in the Yagusa district, employing 128 men and eight women. Available cost and production statistics for Yagusa district are summarized in Tables I and 9.

TABLE I. - PRODUCTION OF KIBUSHI BY MINES IN YAGUSA DISTRICT, 1945-48
(metric tons)

Mine	1945	1946	1947	1948	Total
Hotoku	2,700	2,615	1,525	600	7,440
Mukaida	ND	ND	2,110	2,592	4,702
Shiho	845	1,422	1,890	1,546	5,703
Shinagawa Yagusa	658	600	500	1,308	3,066
Tokai Yagusa	2,494	2,336	2,847	5,009	12,686
TOTAL	6,697	6,973	8,872	11,055	33,597

ND: No data available
SOURCE: 1945-47, individual mine owners; 1948, Mining Bureau.

Hara District: The mines of the Hara district are in Ena-gun and Toki-gun of Gifu Prefecture at altitudes of 300-600 meters (Figure 8). They are in grid area 1225-1355 on AMS L571 (Central Japan), scale 1:250,000, Sheet 28 (Iida), and on AMS L774 (Central Honshu), scale 1:50,000, Sheet 5552-II (Asuke).

The Hara district is an important source of gaerome, estimated to contain about 2,000,000 metric tons of reserves. Mining methods are as good as, and washing plants generally better than, any others in central Honshu. Hara has the brightest future prospects of all the clay-producing districts in Japan. All Hara deposits are worked as open pits. The high quality of washed gaerome from Hara is maintained by constant supervision of washing plants by clay consumers, notably Nippon Gaishi Kabushiki Kaisha of Nagoya.

The Hara district at present has an average monthly production of about 350 metric tons of washed gaerome. Nippon Gaishi KK receives 150 tons for manufacture of electrical porcelain, 70 tons are used for export chinaware, and 30 tons are used for export sanitary ware. In addition the district produces about 150 tons of unwashed gaerome which is used in the manufacture of ceramics for Japanese consumption. A lesser amount of sagger-grade kibushi also is produced in Hara. Significant production from the Hara district began about 25 years ago.

In March 1948, 139 men and 11 women were engaged in mining clay in the 10 mines in the Hara district. Cost and production statistics are summarized in Tables J, K, and 10.

TABLE J. - PRODUCTION OF KIBUSHI BY MINES IN HARA DISTRICT, 1945-48
(metric tons)

Mine	1945	1946	1947	1948	Total
Maruhara	ND	ND	ND	2,833	2,833
Maruichi	ND	ND	ND	488	488
Maruni	1,000	1,100	1,400	0	3,500
Sone	129	119	130	320	698
Tsurusato	607	553	1,891	892	3,943
TOTAL	1,736	1,772	3,421	4,533	11,462

ND: No data available
SOURCE: 1945-47, individual mine owners; 1948, Mining Bureau.

TABLE K. - PRODUCTION OF GAEROME BY MINES IN HARA DISTRICT, 1945-48
(metric tons)

Mine	1945	1946	1947	1948	Total
Kaneichi	ND	ND	2,530	4,013	6,543
Marue	ND	1,875	270	687	2,832
Maruhachi	ND	ND	ND	1,381	1,381
Maruhara	4,136	2,775	4,330	6,308	17,549
Maruichi	ND	ND	970	139	1,109
Maruman	234	1,126	1,052	2,428	4,840
Marunaka	210	858	883	2,711	4,662
Maruni	1,000	1,100	1,400	1,546	5,046
Sone	16,495	7,520	6,925	12,434	43,374
TOTAL	22,075	15,254	18,360	31,647	87,336

ND: No data available
SOURCE: 1945-47, individual mine owners; 1948, Mining Bureau.

CLAY MINES OF HARA DISTRICT

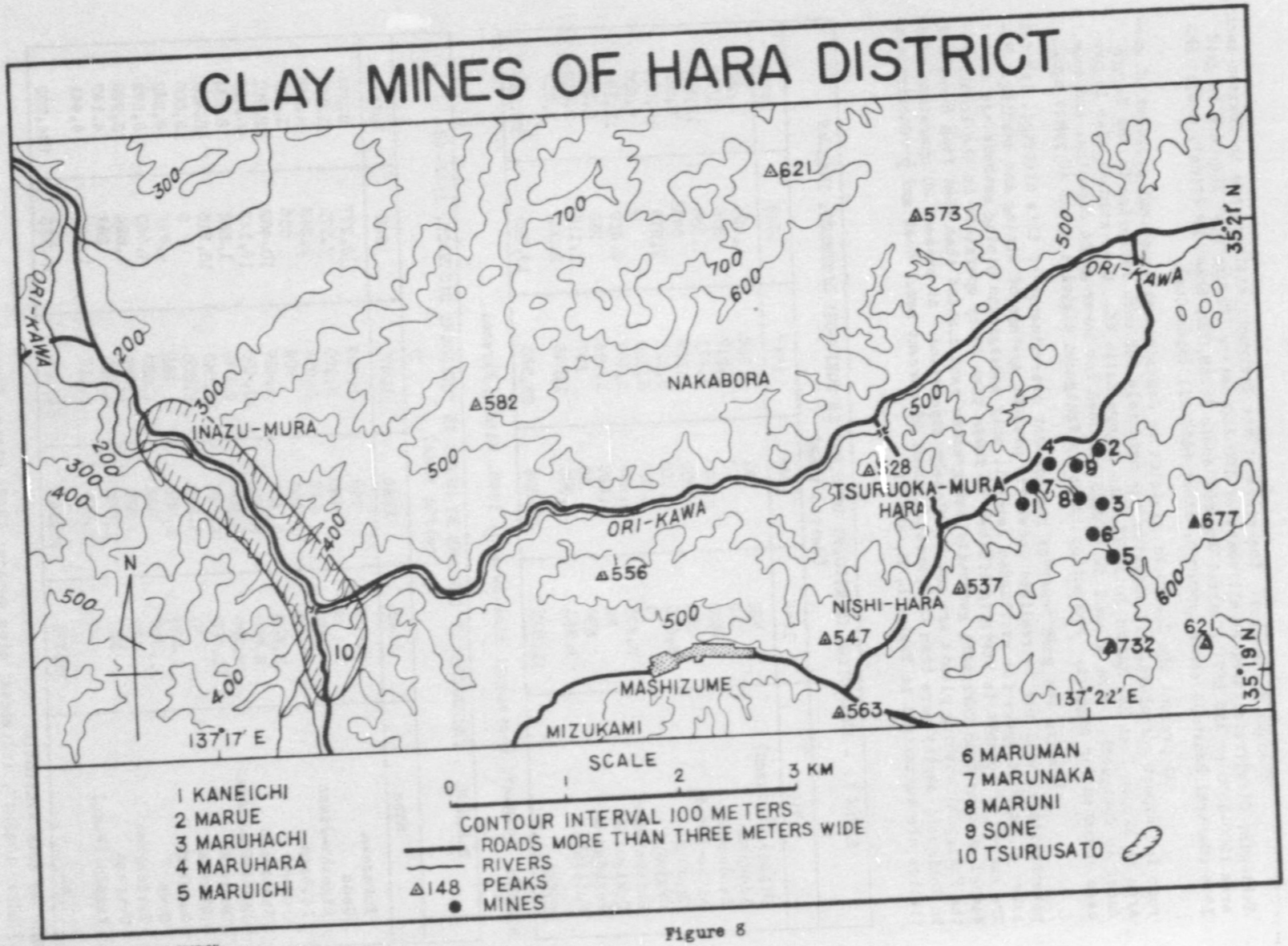


Figure 8

Tokiguchi District: The mines of the Tokiguchi district are in Tokitsu-machi, Toki-gun, Gifu Prefecture, at altitudes of 100-220 meters (Figure 9). They are in grid area 1200-1375 on AMS L571 (Central Japan), scale 1:250,000, Sheet 28 (Iida), and on AMS L774 (Central Honshu), scale 1:50,000, Sheet 5553-III (Mino-Ota).

At present the Tokiguchi district is Japan's most important producer of gaerome for export porcelain. It supplies raw materials for such factories in the Nagoya area as Nippon Toki KK, Narumi Seito KK, and Nagoya Seito KK. Good kibushi also is produced in Tokiguchi. Some kibushi is washed and used for lower-grade ceramics, and some is used unwashed for saggers. Production began in Tokiguchi district about 40 years ago.

Despite the good reserves and present pre-eminence of this district, its full potentialities will not be realized under its present systems of mining and washing. Because of lack of space for overburden removal, only underground mining methods are used. The number of tunnels is strictly limited to fewer than 30 by operators in the locality. Washed gaerome from Tokiguchi generally has greater sand content than that from Hara, and the Tokiguchi washing plants are not so closely supervised. At present 20 operating mines in Tokiguchi employ more than 450 persons, about 85 percent men. Cost and production statistics are summarized in Tables L, M, and 11.

TABLE L. - PRODUCTION OF KIBUSHI BY MINES IN TOKIGUCHI DISTRICT, 1945-48
(metric tons)

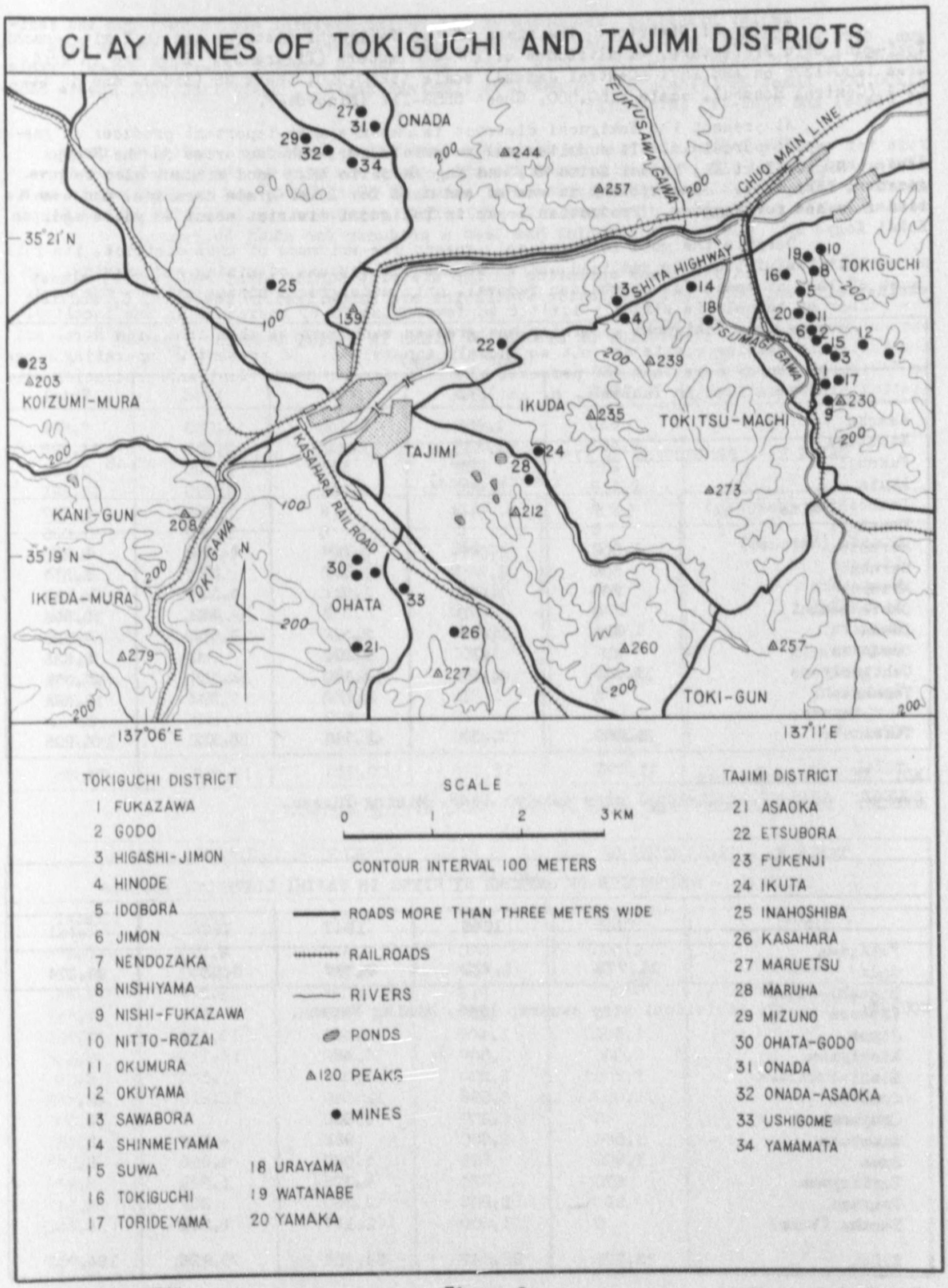
Mine	1945	1946	1947	1948	Total
Hinode (Maruesu)	722	581	968	1,990	4,261
Idobora	0	0	1,517	575	2,092
Nendozaka	600	2,800	3,611	4,538	11,549
Nitto-Kozai	300	1,000	1,239	543	3,082
Okumura	4,000	4,820	5,526	2,678	19,024
Okuyama	0	3,300	5,300	0	8,600
Shinmeiyama	3,600	2,285	2,480	2,819	11,184
Tokiguchi	36	1,220	1,196	753	3,205
Torideyama	670	30	597	1,115	2,412
Watanabe	1,965	2,300	1,546	2,002	7,813
TOTAL	11,893	18,336	23,980	19,013	73,222

SOURCE: 1945-47, individual mine owners; 1948, Mining Bureau.

TABLE M. - PRODUCTION OF GAEROME BY MINES IN TOKIGUCHI DISTRICT, 1945-48
(metric tons)

Mine	1945	1946	1947	1948	Total
Fukazawa	2,500	900	2,697	2,277	8,374
Godo	0	930	3,100	7,071	11,101
Higashi-Jimon	905	613	1,088	2,243	4,849
Idobora	0	250	809	556	1,615
Jimon	3,600	1,400	7,499	10,402	22,901
Nishiyama	8,000	3,800	10,486	18,142	40,428
Nishi-Fukazawa	3,800	1,200	2,006	1,558	8,564
Okumura	11,000	6,598	12,045	15,815	45,458
Okuyama	0	5,200	6,800	0	12,000
Sawabora	1,500	1,000	985	4,797	8,282
Suwa	1,800	826	1,087	4,860	8,573
Torideyama	670	330	1,375	1,594	3,969
Urayama	ND	1,500	2,360	287	4,147
Yamaka (Wake)	0	1,000	2,117	1,324	4,441
TOTAL	33,775	25,547	54,454	70,926	184,702

ND: No data available
SOURCE: 1945-47, individual mine owners; 1948, Mining Bureau.



NATURAL RESOURCES SECTION

Figure 9

Tajimi District: The mines of the Tajimi district are in Toki-gun and Kani-gun, Gifu Prefecture, at altitudes of 80-200 meters (Figure 9). They are in the area bounded by grid coordinates 1205, 1216, 1371, and 1380 on AMS L571 (Central Japan), scale 1:250,000, Sheet 28 (Iida), and on AMS L774 (Central Honshu), scale 1:50,000, Sheets 5552-IV (Seto) and 5553-III (Mino-Ota).

The Tajimi district is divisible into three producing localities, Onada, Ikuta, and Ohata, all of which produce kibushi. Only one mine in the district produces gaerome. The kibushi has refractoriness of about SK 32 (1700°C) and is used mainly as a binder in the manufacture of firebricks. Principal consumers are factories of the Nippon Kokai Kogyo KK. The Tajimi district has been a producer for about 30 years.

The 14 mines now operating in the district employ about 200 people, almost exclusively men. Cost and production statistics are summarized in Tables N, O, and 12.

TABLE N. - PRODUCTION OF KIBUSHI BY MINES IN TAJIMI DISTRICT, 1945-48
(metric tons)

Mine	1945	1946	1947	1948	Total
Asaoka	850	1,450	1,345	4,053	7,698
Etsubora	6,463	1,336	3,649	2,850	14,298
Fukenji	270	250	817	1,329	2,666
Ikuta	2,116	3,600	4,115	4,390	14,221
Inahoshiba (Marusan)	0	0	0	1,757	1,757
Kasahara	0	0	0	1,085	1,085
Maruetsu	1,000	3,000	3,000	1,530	8,530
Maruha	500	1,200	1,200	2,417	5,317
Mizuno	600	1,200	1,200	1,147	4,147
Ohata Godo	0	0	0	10,896	10,896
Onada	900	1,800	2,300	2,920	7,920
Onada Asaoka	ND	ND	2,065	561	2,626
Ushigome	12,600	4,100	16,599	14,171	47,371
Yamamata	0	0	9,000	7,394	16,394
TOTAL	25,299	17,936	45,191	56,500	144,926

ND: No data available
SOURCE: 1945-47, individual mine owners; 1948, Mining Bureau.

TABLE O. - PRODUCTION OF GAEROME BY MINES IN TAJIMI DISTRICT, 1945-48

Mine	1945	1946	1947	1948	Total
Kasahara	11,772	1,772	2,797	3,933	20,274

SOURCE: 1945-47, individual mine owners; 1948, Mining Bureau.

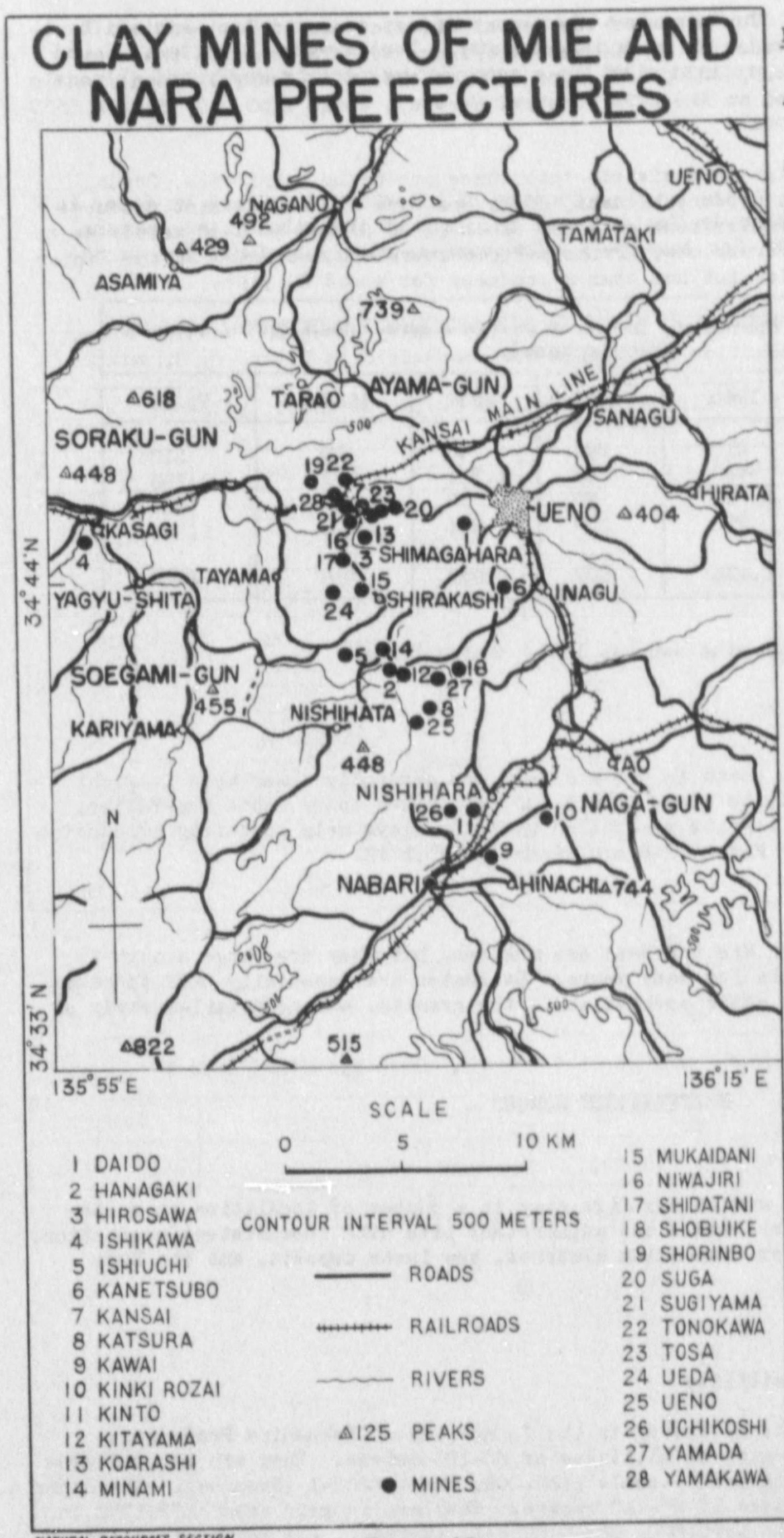


Figure 10

3. Mines of Mie and Nara Prefectures

a. Location and Accessibility

The 28 fire clay mines of Mie and Nara prefectures which are producing at present are in Naga-gun and Ayama-gun, Mie Prefecture, and Soegami-gun, Nara Prefecture, at altitudes of 150-300 meters (Figure 10). They are within the area bounded by grid lines 1101, 1116, 1286, and 1305, on AMS L571 (Central Japan), scale: 1:250,000, Sheet 39 (Uji-Yamada), and on AMS L774 (Central Honshu), scale 1:50,000, Sheets 5351-III (Ueno) and 5350-IV (Nabari).

The mine area is served by the Kansai Main Line and Iga line railroads. Distances from the mines to the railroads are generally less than 10 kilometers over fair to poor roads. The clay is moved to the railroads by truck or horse-cart.

b. History and Ownership

The clay mines of Mie and Nara are owned by individuals or small companies. Data are unavailable on the many sporadic, small-scale producers of the area. Present producing mines, with owners and the years in which mining began, are listed in Table 13.

c. Geology and Mining Methods

The geology of this area is similar to that of the Aichi-Gifu producing area, but less study has been made of the deposits in Mie and Nara. The clays of the two areas have the same type of occurrence and are thought to have been deposited at the same time under similar topographic and climatic conditions.

Mining methods in the two areas also are similar, although the Aichi-Gifu area is developed more efficiently and on a larger scale. Because more lignite is found in the Mie-Nara area, a larger proportion of the mines are worked by underground methods than in Aichi and Gifu.

d. Production

Available data on the past production of kibushi and gaerome by mines in Mie and Nara prefectures are given in Tables P and 14. All of the kibushi and gaerome produced in Mie and Nara is used for low-grade refractories, mostly by factories in the Osaka and Kobe areas.

TABLE P. - PRODUCTION OF GAEROME BY MINES IN MIE AND NARA PREFECTURES, 1945-48
(metric tons)

Mine	1945	1946	1947	1948	Total
Hirosawa	215	245	40	10	510
Kitayama	420	242	1,901	173	2,736
Minami	ND	ND	70	183	253
Shidatani	800	320	261	0	1,381
TOTAL	1,435	807	2,272	366	4,880

ND: No data available
SOURCE: 1945-47, individual mine owners; 1948, Mining Bureau.

e. Costs

Clay production costs in Mie and Nara are generally lower than in Aichi and Gifu. The lower quality of the clays in Mie and Nara makes lower costs imperative, and the greater thicknesses of lignite associated with the clays help to defray production costs. Available cost data for March 1948 are given in Table 13.

f. Reserves

Clay reserves in Mie and Nara are unknown, but they are large enough to support present production levels for many years. Estimates are especially hard to make because the clay occurs in many small pockets above the granite, and no detailed study of the deposits has yet been made.

NORTHEASTERN HONSHU

1. General

Tertiary sediments are worked for fire clay in a number of localities in northeastern Honshu. Most workings are small and unimportant pits with inconsistent production. Three areas are worthy of mention, the Joban district, the Iwate deposit, and the Kuji deposit.

2. Joban Area

a. Location and Accessibility

Seven clay mines are operating in the Joban area of Fukushima Prefecture (Figure 11). Two are in Futaba-gun, at altitudes of 60-100 meters. They are in grid area 1598-1782 on AMS L793 (Northern Honshu), scale 1:50,000, Sheet 6258-I (Kawamae). The other five are in Iwaki-gun, at altitudes of 50-150 meters. They are in grid area 1578-1782 on AMS L773 (Northern Honshu), scale 1:50,000, Sheet 6258-II (Taira). All seven mines are on AMS L571 (Central Japan), scale 1:250,000, Sheet 16 (Koriyama).

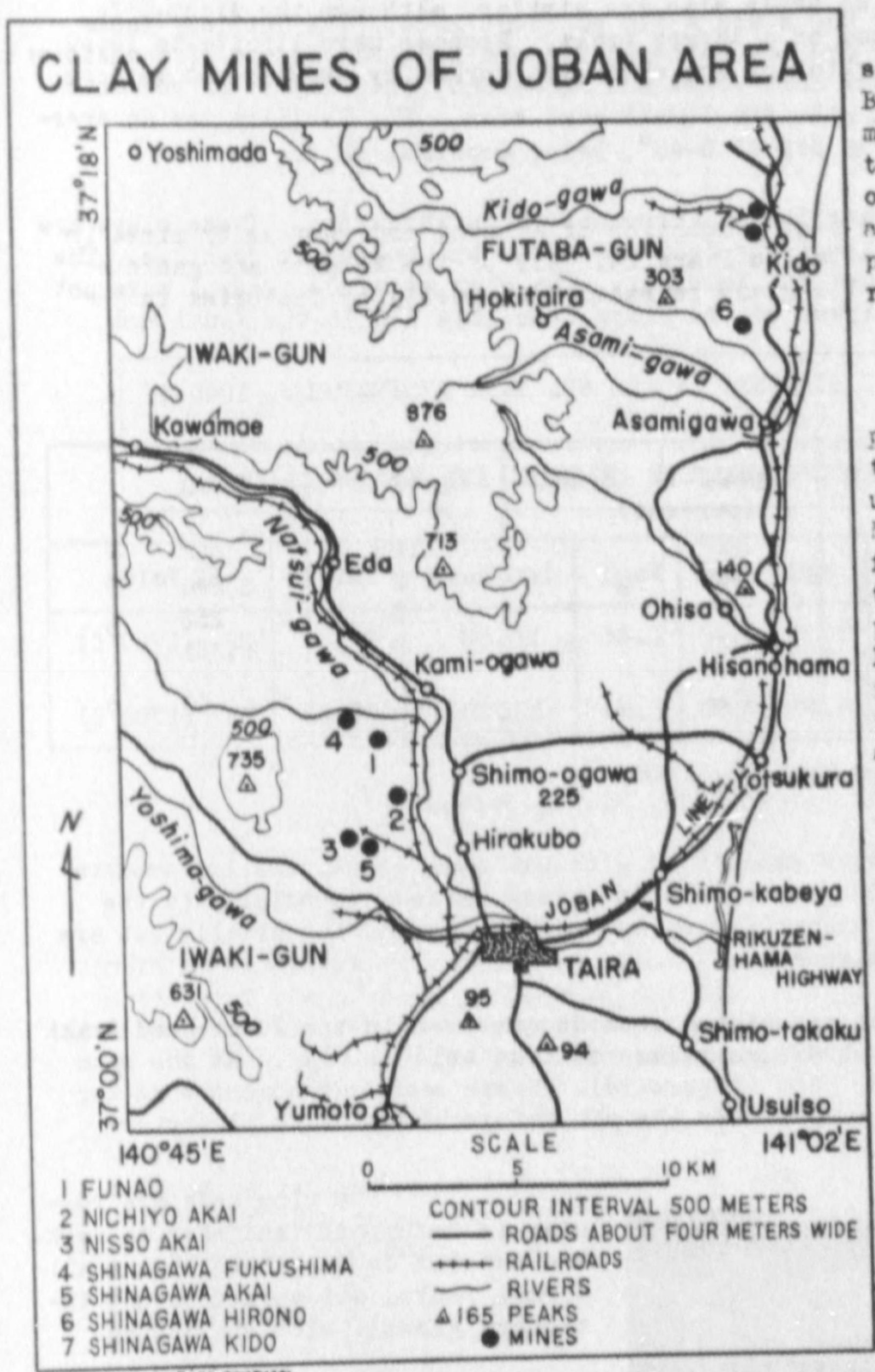


Figure 11

The mine area is served by the Joban Line and the Banetsu Line. Distances from the mines to the railroads range from two to five kilometers, usually over one-lane dirt roads. Trucks and horse-carts are used for transportation between the mines and the railroads.

b. History and Ownership

Fragments of broken pottery found near Hirono indicate that the clays from Futaba-gun were used for tableware many years ago. More recently, however, the clays from Iwaki-gun were the first from the Joban area to receive wide application in the refractory field. Fire clay was discovered near Akai in 1885 and used in small quantities for tiles and firebricks until about 1912. In 1916-17, under the stimulus of World War I, the mines of the Akai locality produced an estimated 70,000 tons of fire clay annually. Later production declined sharply but rose again to about 20,000 tons a year in 1940-41. Significant production of fire clay from the Hirono locality did not begin until about 1933. During 1938-43, fire clay production from this locality averaged over 20,000 tons a year.

Mines at present operating in the Joban area are listed in Table 15. By far the greater part of the clay production from the Joban area has come from the mines of Shinagawa Shirorenga KK. This company was established in 1875 to manufacture firebricks in Tokyo under the direction of a French engineer. Until 1908 the company specialized mostly in the manufacture of firebricks, buying the raw material from small producers in the Joban area. Since 1908, however, the company has acquired the main fire clay producing mines of the area to supply its factories.

c. Geology and Mining Methods

The geology of the Futaba and Iwaki localities is the same and their clays are similar in occurrence, so only Futaba will be described in detail.

The fire clays of Futaba-gun are in the lower part of a series of transgressive deposits which were laid down in late Oligocene (Aquitanian) time on the continental shelf east of the Abukuma mountain area. The Abukuma complex, consisting of Paleozoic granite and diorite intrusives and the Paleozoic Gozaisho series of amphibolites and phyllites, now outcrops as a series of low, rolling hills to the west of the Tertiary outcrops. The Futaba Cretaceous formation, comprising more than 300 meters of sandstone and shales, is nonconformable on the Paleozoic rocks and outcrops chiefly in the southern part of the

area with an average strike of about N20°W and a dip of about 20°E. The Tertiary rocks overlie the Cretaceous unconformably and are composed of more than 350 meters of sandstones and shales which contain four separate coal seams and occasional thin layers of volcanic tuff. The fire clays are associated with the lowest coal seam. The Tertiary has an average north-south strike and an easterly dip of 5-45°, being steepest in the north.

The workable clay beds are two or three meters in thickness. These clays are the transported decomposition products of the feldspars from the Paleozoic granites. The fresh granite contains more than 50 percent feldspar. The clay minerals present have not been determined. Representative analyses of the clays from this bed in the Iwaki and Futaba localities are shown:

TABLE Q. - REPRESENTATIVE ANALYSES OF IWAKI AND FUTABA CLAYS
(percent)

Locality	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	Ign Loss	Total	SK Value
Iwaki (Akai)	48.91	36.15	0.84	0.37	0.50	0.40	1.44	10.83	99.44	32 (1700°C)
Futaba	50.10	34.20	1.00	0.38	0.40	0.80	1.50	11.20	99.58	32 (1700°C)

SOURCE: Research Institute, Shinagawa Shirorenga KK.

In addition to the deposits associated with the coal seams, smaller amounts of residual weathering products of the granite are sometimes worked, especially in the Iwaki locality. These clays contain higher percentages of silica and the alkalis but are used without washing for refractory purposes.

Both underground and open pit mining methods are used in the Futaba and Iwaki localities. Most of the underground workings produce coal as well as clay. At the open pits the clay is loaded and tramned by hand (Figure 12). Where much carbonaceous matter is present, the clay is preburned in mounds near the pit before shipment to firebrick factories.

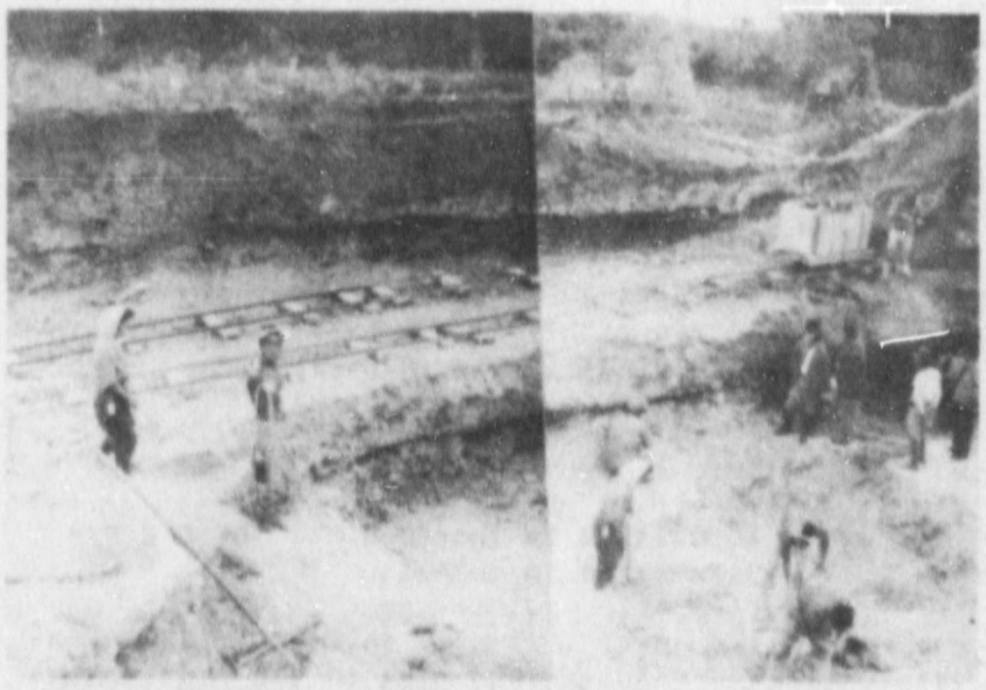


Figure 12. - Clay digging at the Kido mine, showing digging and loading operations typical of the Joban area. Kido-mura, Futaba-gun, Fukushima Prefecture, October 1948.

The clay beds are regular in occurrence and easy to work. One deposit is displaced by a small normal fault, but this does not interfere greatly with operations.

d. Production

Available production data of mines in the Joban area are summarized in Table 16. Most of this production has been for the manufacture of firebricks by the factory of Shinagawa Shirorenga KK in Yumoto, Kashima-mura, Iwaki-gun.

e. Costs

Cost statistics available do not afford a good basis for comparison because the data for the various mines were compiled on different dates and the effects of seasonal labor and rising costs are difficult to estimate. Available data are summarized in Table 15.

f. Reserves

Ore reserves as listed by the mine owners are given in Table R. Although these are the best data available, most of the figures are probably too high.

TABLE R. - FIRE CLAY RESERVES IN JOBAN AREA
(metric tons)

Mine Claim	Workable Reserves	
	Proved	Possible
Funao	150,000	4,500,000
Nichiyo Akai	30,000	27,000
Nisso Akai	130,000	ND
Shinagawa Akai	3,500,000	ND
Shinagawa Fukushima	3,000,000	ND
Shinagawa Kido	30,000	ND
Shinagawa Hirono	3,000,000	ND
TOTAL	9,840,000	4,527,000

ND: No data available

3. Iwate Deposit

a. Location and Accessibility

The Iwate mine, Japan's most important producer of flint-type clay, is located at Yokomichi, Kogawa-mura, Shimohei-gun, Iwate Prefecture, at an altitude of about 400 meters (Figure 13). It is at coordinates 872-1927 on AMS L571 (Central Japan), scale 1:250,000, Sheet 7 (Morioka), and on AMS L773 (Northern Honshu), scale 1:50,000, Sheet 6466-IV (Kado).

The clay is transported by aerial tram from Yokomichi to Owatari, about 11 kilometers, and by truck from Owatari to Utsuno, about five kilometers. The Omoto Line railroad extends 25 kilometers from Utsuno to the Moichi station of the Yamada Line. The Yamada Line extends west to join the Tohoku Main Line at Morioka and east to the port of Miyako.

The large investments apparent in the loading and calcining facilities at the mine and in the aerial tramways indicate the importance which the Japanese attached to this deposit of highly refractory clay, in the absence of imports of high-aluminum shale from north China and Manchuria.

Transportation is a particular problem in the working of the Iwate clay. Heavy rains in autumn frequently wash out parts of the Yamada Line, and repairs sometimes take months. During the fall and winter of 1948-49, the entire production of the mine had to be moved by truck about 75 kilometers over fair roads to the Numakunai station of the Tohoku Main Line. Of course, only the good quality of the clay found in the Iwate deposit made such an operation economic.

Various plans are under consideration to improve the transportation situation. One is the extension of the Omoto Line from Utsuno to the mine via Ochiai. Another is the extension of the aerial tramway from Owatari to Miyako. Lack of capital at present prevents putting either of these plans into effect.

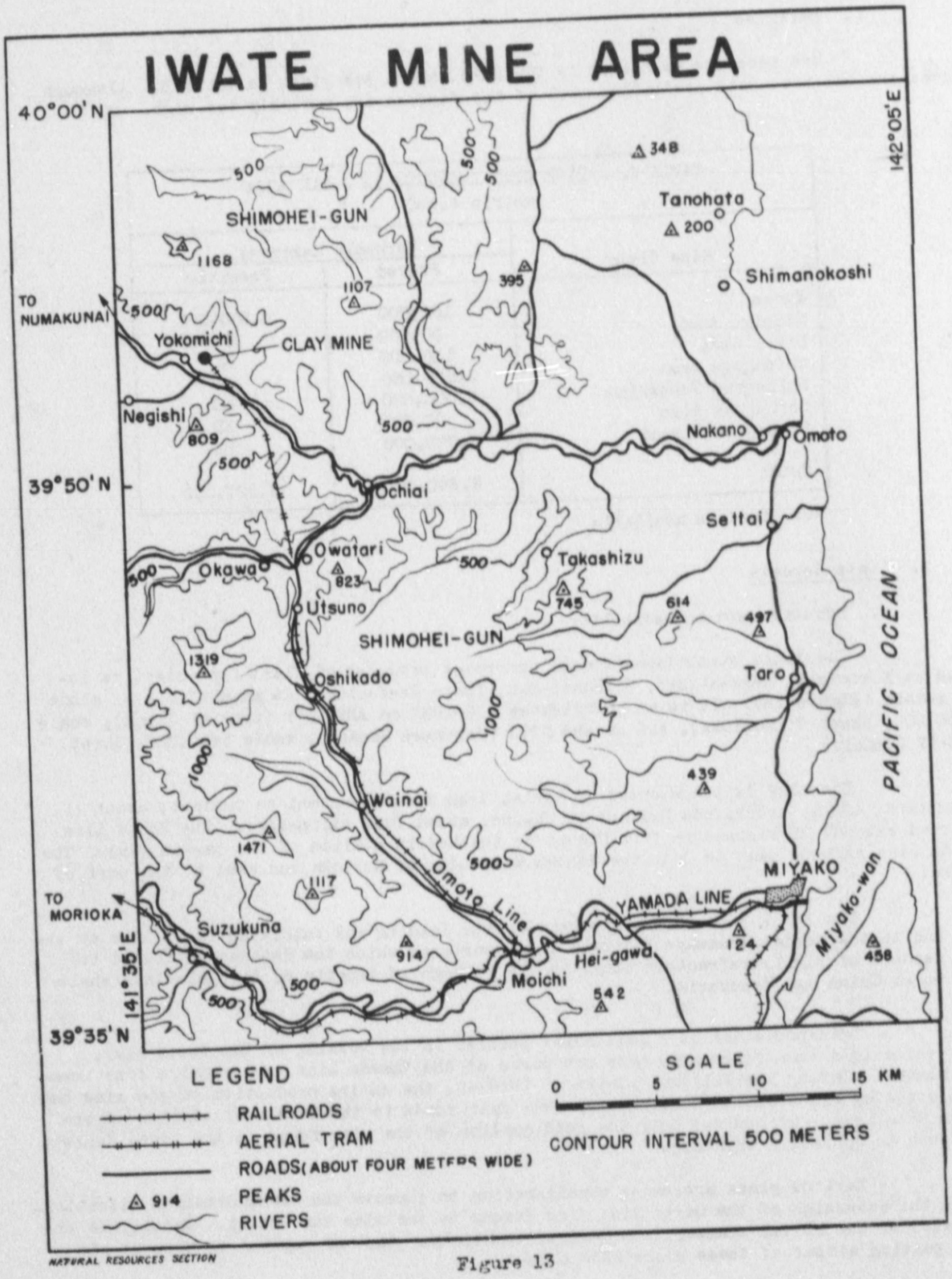
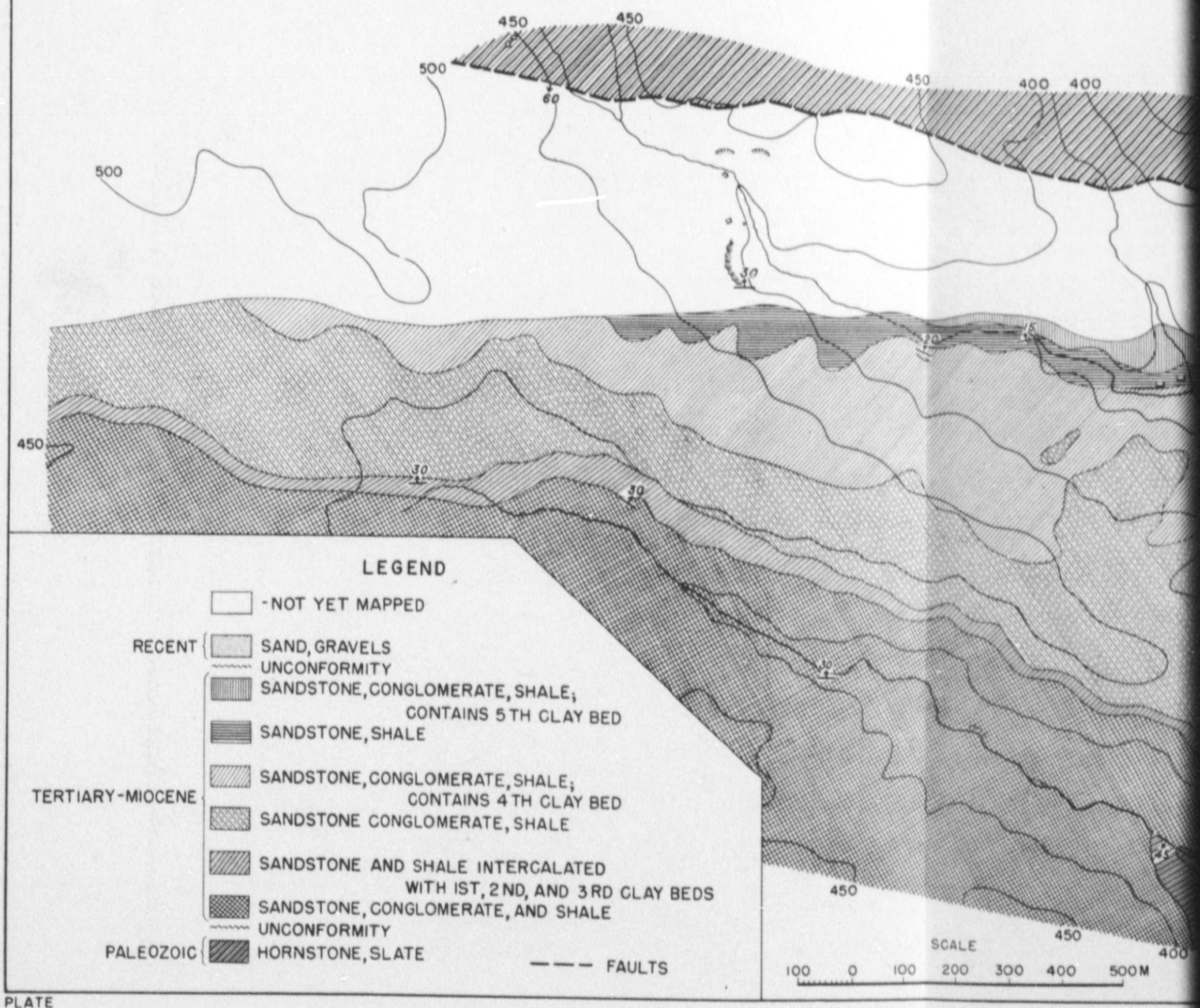

IWATE MINE AREA
40°00'N
142°05'E
39°50'N
39°35'N
141°35'E
SHIMOHEI-GUN
1168
1107
500
TO NUMAKUNAI
Yokomichi
CLAY MINE
Negishi
809
Ochiai
Owatari
823
Okawa
Utsuno
1319
Oshikado
Wainai
1471
1117
Suzukuna
914
Moichi
542
Omoto Line
TO MORIOKA
△348
Tanohata
△200
Shimanokoshi
395
Nakano
Omoto
Seitai
Takashizu
745
614
497
SHIMOHEI-GUN
Taro
439
1000
PACIFIC OCEAN
MIYAKO
YAMADA LINE
124
Miyako-wan
458
Hei-gawa
LEGEND
RAILROADS
AERIAL TRAM
ROADS (ABOUT FOUR METERS WIDE)
△914 PEAKS
RIVERS
SCALE
0 5 10 15 KM
CONTOUR INTERVAL 500 METERS
NATURAL RESOURCES SECTION

Figure 13

GEOLOGIC MAP OF IWATE MIN

(AFTER M. MURAOKA, JAPANESE GEOLOGICAL SURVEY)



LEGEND

- NOT YET MAPPED

RECENT
- SAND, GRAVELS
- UNCONFORMITY

TERTIARY-MIOCENE
- SANDSTONE, CONGLOMERATE, SHALE; CONTAINS 5TH CLAY BED
- SANDSTONE, SHALE
- SANDSTONE, CONGLOMERATE, SHALE; CONTAINS 4TH CLAY BED
- SANDSTONE CONGLOMERATE, SHALE
- SANDSTONE AND SHALE INTERCALATED WITH IST, 2ND, AND 3RD CLAY BEDS
- SANDSTONE, CONGLOMERATE, AND SHALE
- UNCONFORMITY

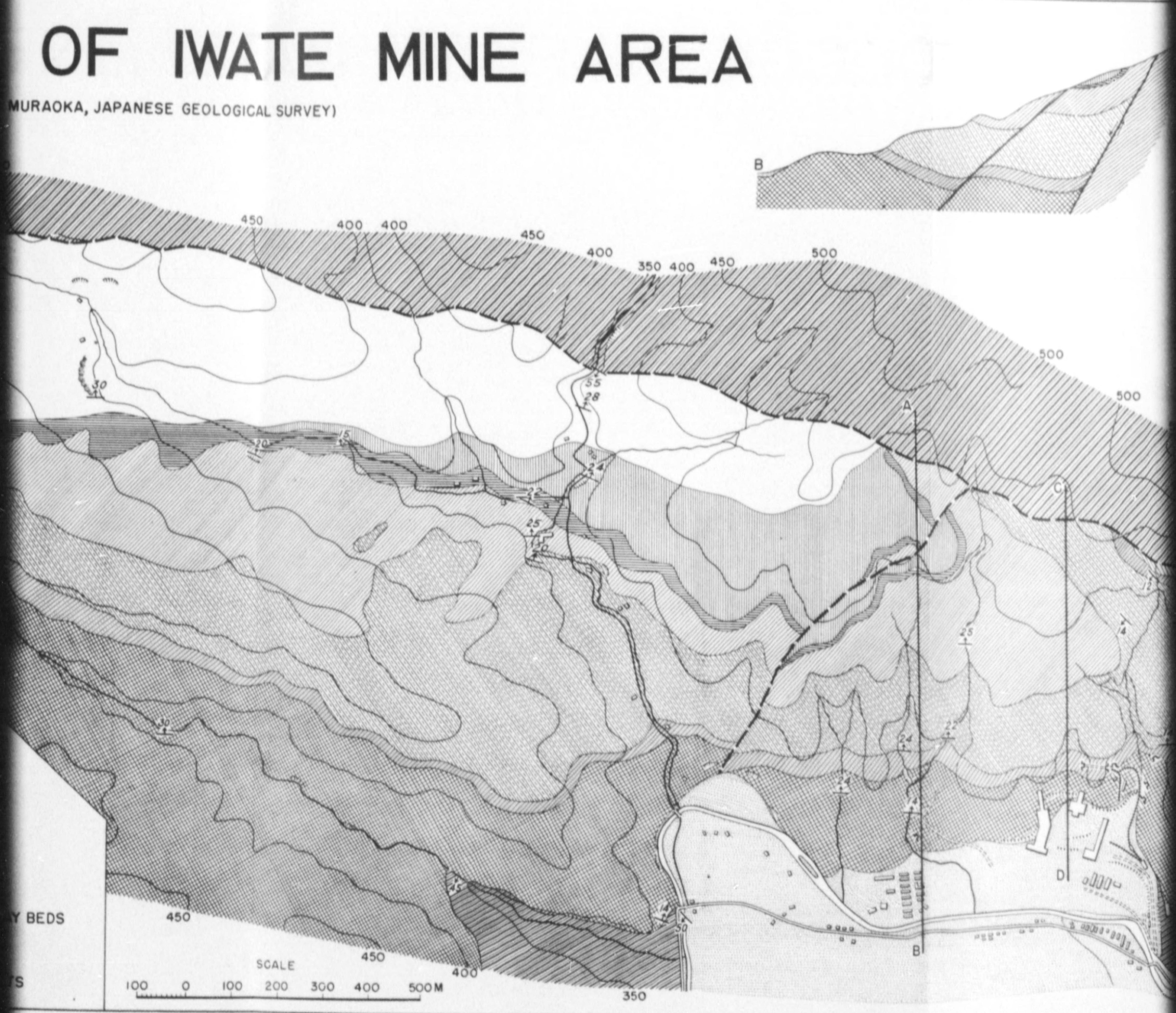
PALEOZOIC
- HORNSTONE, SLATE

——— FAULTS

PLATE

OF IWATE MINE AREA

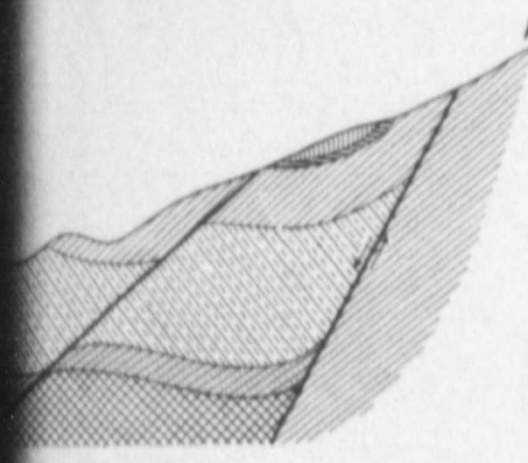
MURAOKA, JAPANESE GEOLOGICAL SURVEY)

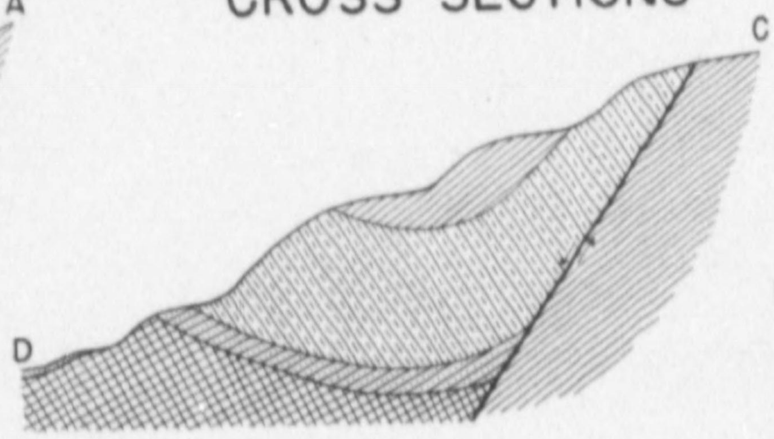


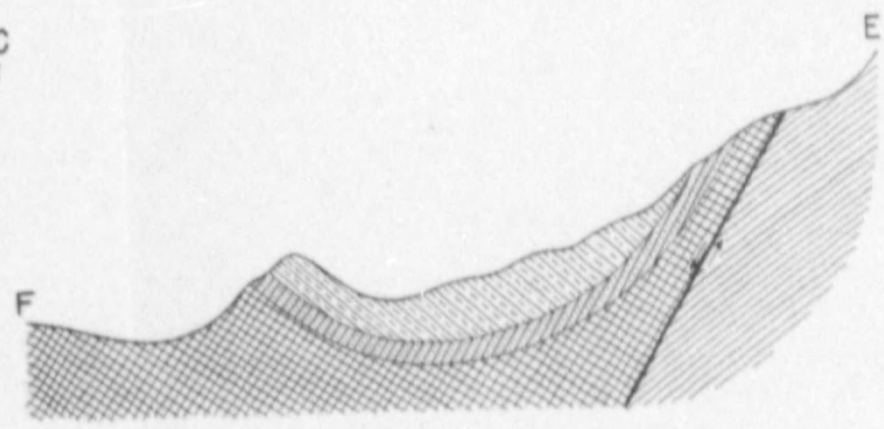
Y BEDS

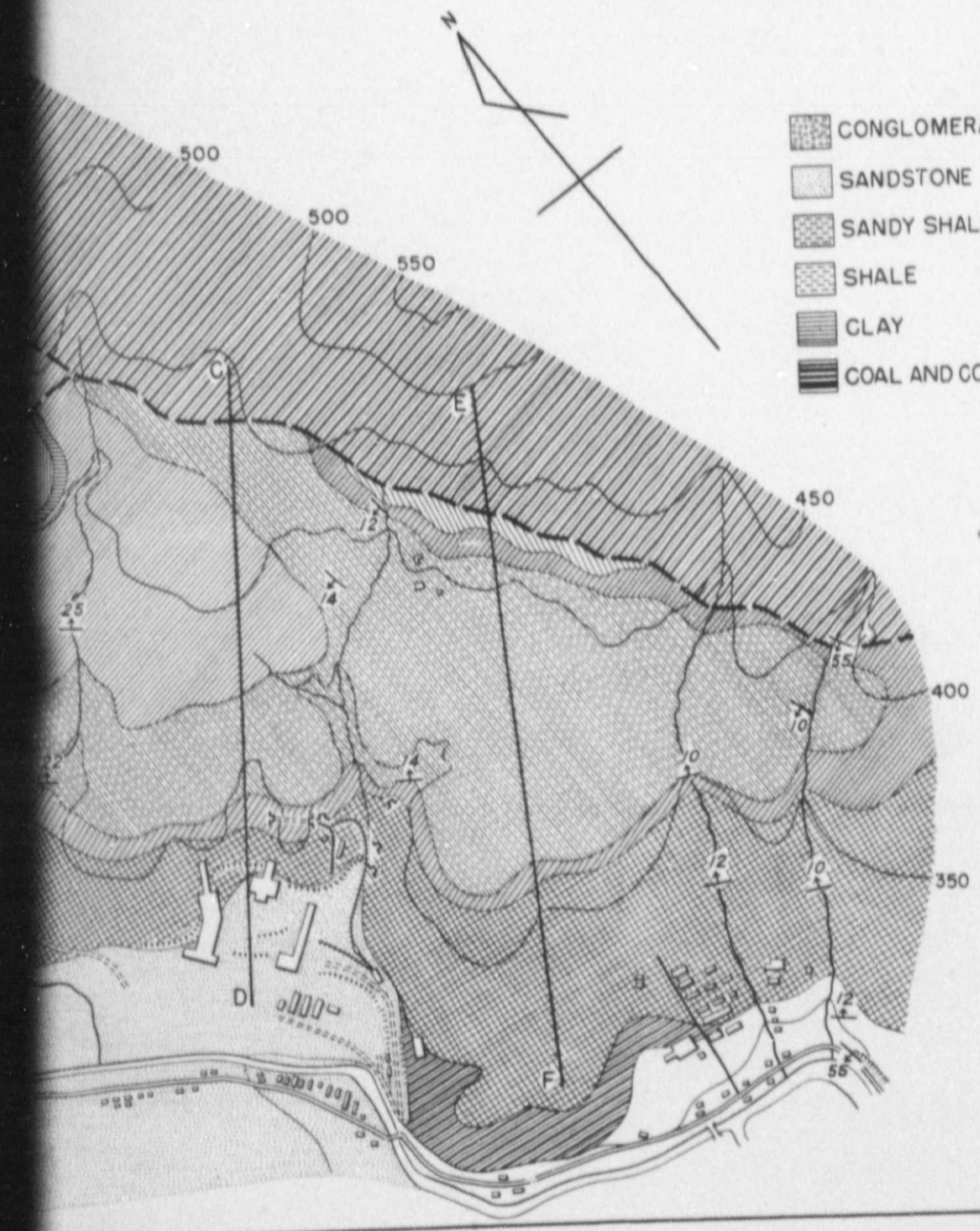
TS

CROSS SECTIONS



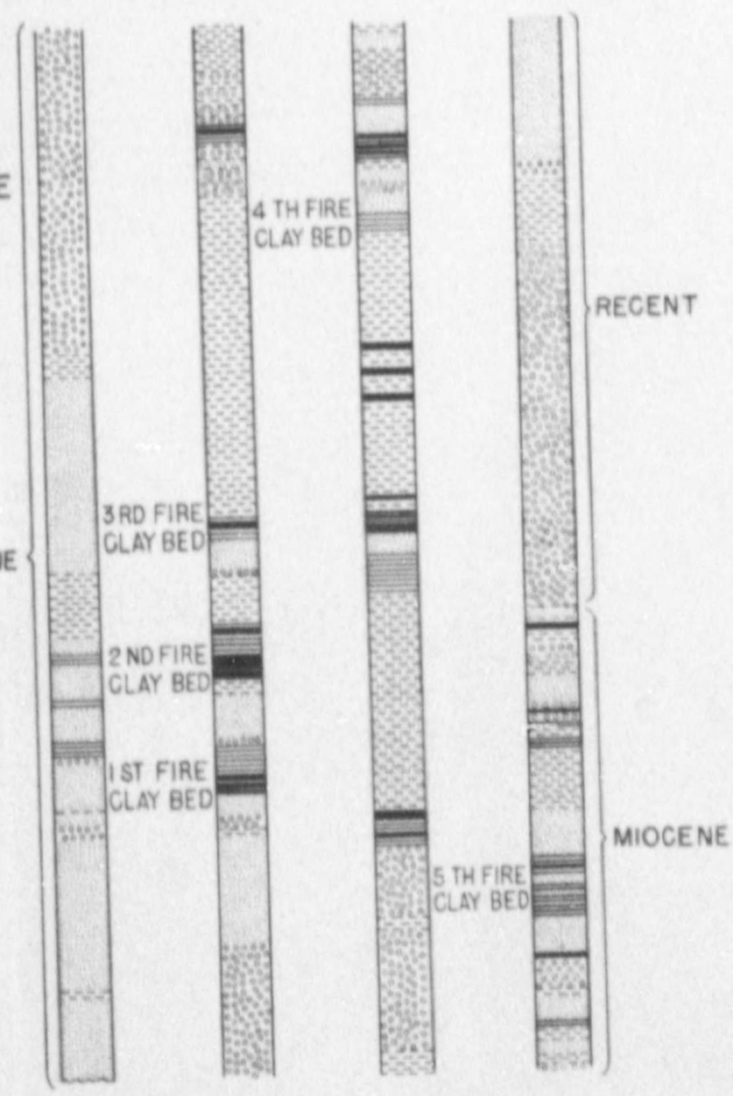






CONGLOMERATE
SANDSTONE
SANDY SHALE
SHALE
CLAY
COAL AND COALY SHALE

COLUMNAR SECTION



VERTICAL SCALE
(COLUMNAR SECTION)

10 0 10 20 30 40 M

b. History and Ownership

The existence of coal reserves in the Yokomichi area had been known for many years, but no development had been undertaken until December 1921, when the Tohoku Tetsudo Kogyo KK was established to work these reserves. However, transportation and financial difficulties precluded immediate development of the deposit. In 1935 the company was reorganized as the Iwate Tanko Tetsudo KK. Aerial tramways were constructed, and production of coal began in 1936. About a year later the refractory qualities of the associated clay were discovered, and since that time the Iwate mine has achieved greater importance as a clay producer than as a coal producer. From December 1941 to September 1945 the Iwate mine was under the management of Nittetsu Kogyo KK. In 1948 Iwate Tanko Tetsudo KK was renamed the Iwate Yogyo Kozan KK.

c. Geology and Mining Methods

The fire clay is associated with coal seams and occurs in about 330 meters of sandstones, shales, and conglomerates, all Miocene sediments (see Plate, "Geologic Map of Iwate Mine Area"). The Miocene rocks rest unconformably on Paleozoic rocks, which have been partially metamorphosed by granitic intrusives, and occur as a gentle syncline in a valley between two masses of these Paleozoics. The synclinal axis strikes about N35°W and pitches from 0-5°NW. The northern contact between the Miocene and Paleozoics is a reverse fault which strikes about N60°W and dips about 55°SW, cutting off the northern part of the syncline to the west.

Five distinct beds of refractory clay, all of variable thickness and quality, are recognizable. Present knowledge of the deposits indicates that only three of these seams are workable. The clays are generally of higher quality in the eastern part of the area, becoming increasingly sandy toward the west. The refractoriness of the clay varies between SK 30 and SK 34 (1650-1760°C), but most of the production has been SK 32 (1700°C), or slightly higher. Preliminary examinations indicate that the main clay mineral is kaolinite, with halloysite predominant in the most refractory portions. The clay is still under study by the Ceramic Raw Materials Research Committee, Ministry of Education. Representative analyses of the clay, as determined by the Nippon Kokan KK laboratory, are as follows:

TABLE 5. - REPRESENTATIVE ANALYSES OF IWATE CLAY
(percent)

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Ign Loss	Total	SK Value
48.31	34.46	1.91	0.49	0.48	14.48	100.13	33-34 (1745-1760°C)
55.75	28.39	2.86	0.45	0.51	13.56	101.52	30-32 (1650-1700°C)

Exact data are not available, but the Iwate fire clay is said to have a low rate of shrinkage and to produce firebricks of good strength and quality.

At present the deposit is worked by three inclined adits and 4,000 meters of drifts, using a modified room-and-pillar method. Maximum recovery could be achieved by applying the retreating longwall system, which is under consideration at present. Open pit operations are planned in the eastern part of the area where the clay beds outcrop. This will interfere with agriculture and with the application of the Land Reform Law in the area. However, in December 1948 the Iwate Yogyo Kozan KK received permission from the Ministry of Agriculture and Forestry to proceed with open pit operations.

d. Production

Data on the mine's clay production (Table T) include all shipments of both raw and burned clay. About 30 percent of the production, chiefly the bituminous clay, is preburned at the mine in cylindrical kilns about 15 meters high. The ratio of clay burned to coal used is about 1:3. Each of the four kilns in operation has a capacity of about 12 tons of burned clay in 24 hours.

TABLE T. - PRODUCTION OF FIRE CLAY BY IWATE MINE, 1939-48
(metric tons)

Year	Production
1939	4,500
1940	5,000
1941	18,000
1942	25,500
1943	57,900
1944	124,140
1945	75,808
1946	6,522
1947	1,171
1948	23,149
TOTAL	341,690

SOURCE: Mine officials

The main purchasers of the Iwate fire clay and the percent purchased are: Wanishi foundry, Nihon Seitetsu KK, 20; Kamaishi foundry, Nihon Seitetsu KK, 20; Miyako ceramic plant, Iwate Yogyo Kozan KK, 20; Nippon Kokan KK, 10; Shinagawa Shirorenga KK, 10; Nippon Yogyo Kogyo KK, 5; others, 15.

Coal production from the Iwate mine is reported as follows:

TABLE U. - PRODUCTION OF COAL BY IWATE MINE, 1936-48
(metric tons)

Period	Production
Jan-Dec 36	7,000
Jan-Dec 37	10,000
Jan-Dec 38	4,000
Jan-Dec 39	8,000
Jan-Dec 40	11,000
Jan-Mar 41	4,000
Apr 41-Mar 42	14,000
Apr 42-Mar 43	13,000
Apr 43-Mar 44	8,000
Apr 44-Mar 45	3,000
Apr 45-Mar 46	5,000
Apr 46-Mar 47	11,000
Apr 47-Mar 48	10,000

SOURCE: Coal Board, Ministry of International Trade and Industry.

e. Costs

According to mine officials, cost of production in August 1945 was ¥88 a ton. Costs have risen steadily since that time. In May 1946 the cost was ¥354 a ton, in January 1948 it was ¥785, and by August 1948 it had risen to ¥1,154. Details of the August 1948 costs are given in Table 17.

f. Reserves

Because of the variable thickness and quality of the fire clays, reserve estimates vary widely. The most reliable estimate yet made of maximum recoverable reserves (Table V) is based on surface data and data obtained from underground workings and from trenching sections. These figures are more conservative than former estimates but still indicate substantial reserves.

TABLE V. - IWATE FIRE CLAY RESERVES
(metric tons)

Quality of Clay	Proved	Probable
Highly refractory (SK 34; 1760°C)	262,500	322,500
Refractory (SK 31-33; 1680-1745°C)	7,515,000	11,160,000
Semi-refractory (SK 29-30; 1640-1650°C)	12,240,000	17,595,000

In addition, about 50,000 tons of clay are stockpiled at the mine adits.

4. Kuji Deposit

a. Location and Accessibility

The Kuji fire clay mine is in Natsui-mura, Kunohe-gun, Iwate Prefecture, at an altitude of about 40 meters. The coordinates are 888.5-1965 on AMS L751 (Central Japan), scale 1:250,000, Sheet 4 (Hachinoe), and on AMS L773 (Northern Honshu), scale 1:50,000, Sheet 6467-I (Kuji). It is about two kilometers by railroad from the mine to Kuji port.

b. History and Ownership

The mine began operations in 1911. Present owner is Mr Chukichi Kaneda.

c. Geology and Mining Methods

Nothing is known of the geology of the deposit. The clays are dug from an open pit by hand methods. An analysis in percent of the clay was made by the Kamaishi laboratory of Nittetsu Kogyo KK:

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Ign Loss	Total
64.84	23.20	2.82	0.44	0.54	8.10	99.94

d. Production

Available production data are shown in Table W, as obtained from the mine owner. The mine was idle from June 1946 to October 1948. Factories in northern and central Honshu are the main consumers of this production.

TABLE W. - PRODUCTION OF FIRE CLAY BY KUJI MINE, 1935-48
(metric tons)

Year	Production
1935	4,000
1936	5,503
1937	2,458
1938	7,068
1939	12,252
1940	12,859
1941	11,753
1942	11,578
1943	6,764
1944	5,828
1945	2,009
1946	173
1947	0
1948	1,164
TOTAL	83,409

e. Costs

In January 1949, 35 men and four women were employed at the Kuji mine. Cost data, in yen per ton at the mine, are given as follows: labor, 413; office, 195; materials, 81; depreciation, 160; total, 849.

f. Reserves

Reserves are estimated by mine officials to be about 1,000,000 metric tons.

NORTHWESTERN KYUSHU

1. General

The mines of the Iizuka area and the Tsukinokawa mine, which are described below, are the only important producers of fire clay in Kyushu. No data are available for the smaller producers in other parts of Kyushu, all of which work on a sporadic basis to satisfy local needs only.

2. Iizuka Area

a. Location and Accessibility

The 21 fire clay mines of the Iizuka area in Kaho-gun, Tagawa-gun, and Kurata-gun, Fukuoka Prefecture, at altitudes of 30-100 meters (Figure 14). They are in the area bounded by grid coordinates 1365, 1390, 1166, and 1184 on AMS L571 (Central Japan), scale 1:250,000, Sheet 45 (Kokura), and on AMS L772 (Kyushu), scale 1:50,000, Sheets 4247-I (Gotoji), 4247-IV (Dazifu), 4248-II (Yukuhashi), and 4248-III (Akama).

CLAY MINES OF IIZUKA AREA

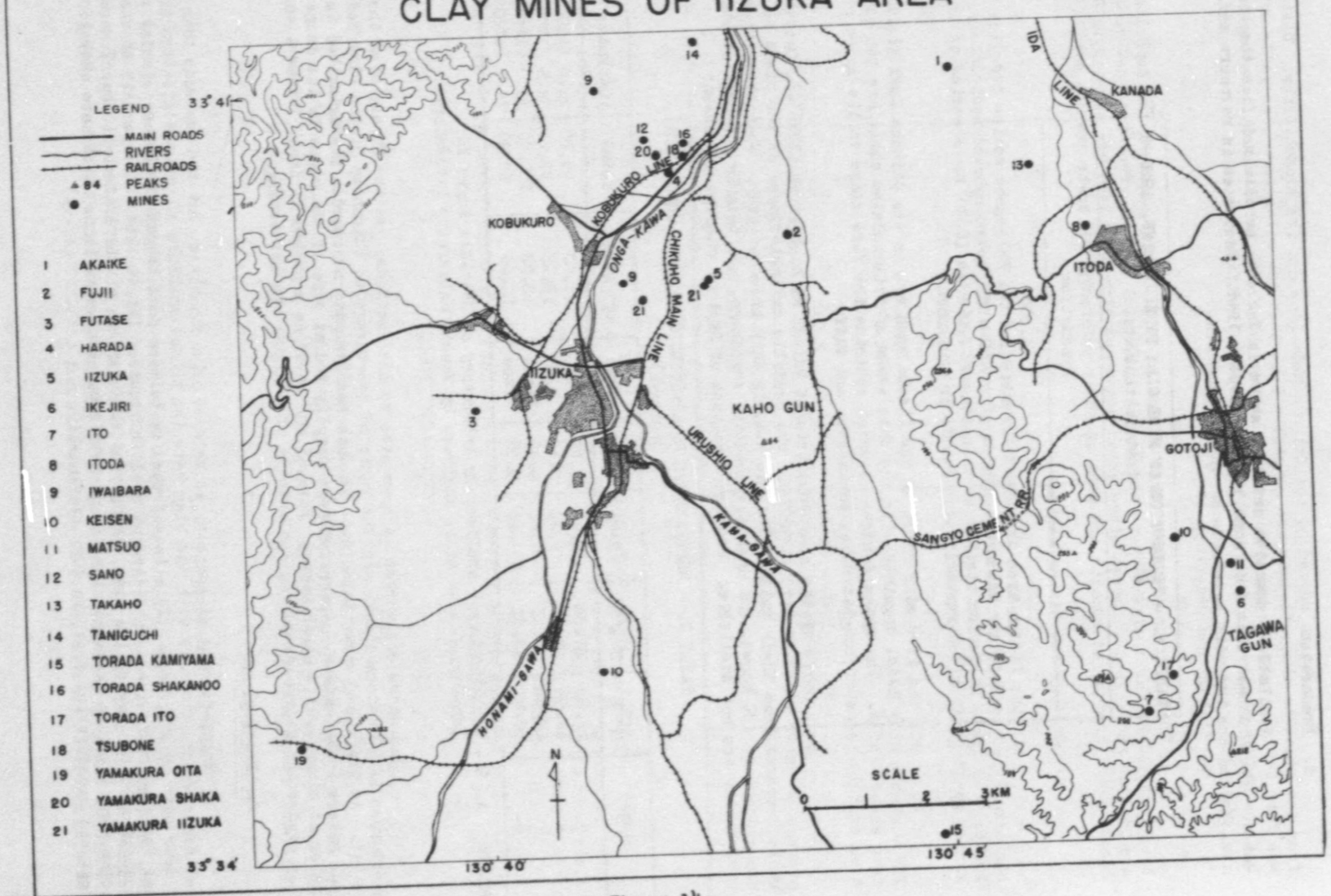


Figure 14

The area is served by the Chikuho Main Line and its branch lines. Distances from the mines to the railroads are generally less than two kilometers over roads which are fair but may become impassable in very wet weather. The largest producers use trucks, but most of the mines use horse-carts for transportation from the mines to railroads.

b. History and Ownership

These fire clays were first worked in 1930. Development of the deposits has been fostered by their proximity to the Yawata industrial center. The mines now producing are listed in Table 18. Seven mines which began operations in 1948 are known only by location and production reports, and data on their ownership and costs are not available.

c. Geology and Mining Methods

In the Iizuka area the Oyake formation of the Paleogene series overlies unconformably a pre-Tertiary basement complex of granite and metamorphosed sedimentary rocks. The Oyake formation strikes north-northwest and dips 15-30°E. A series of normal strike faults with steep westerly dips occurs in the area.

All the fire clay mines of the Iizuka area are in the Chikuho coal field. The workable clay beds, together with the thin seams of intercalated coal, are two to four meters thick. The Oyake formation, which contains the fire clays in its upper part, also contains beds of conglomerate, sandstone, and tuff.

Some parts of the clay beds have SK values as high as 35 (1785°C), but their average SK value is 32-33 (1700-1745°C). The variable refractoriness of the clays as a whole detracts from their value. The raw clay is dark brown to gray. What clay minerals are present is not known, and data on porosity, shrinkage, and tensile strength of the burned clay are not available. Chemical analyses of typical samples are shown:

TABLE X. - REPRESENTATIVE ANALYSES OF IIZUKA AREA CLAYS
(percent)

Sample	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Ign Loss	Total	SK Value
A	57.20	27.66	2.96	0.92	0.03	11.03	99.80	31.5 (1690°C)
B	46.55	34.35	1.42	0.47	0.07	16.95	99.81	34.5 (1770°C)
C	47.52	38.11	0.56	0.48	Trace	13.33	100.00	33.0 (1745°C)
D	42.99	42.61	0.48	0.48	Trace	13.04	99.60	34.0 (1760°C)

SOURCE: A, B - Shakanoo area, analyses by laboratory of Nittetsu Kogyo KK;
C, D - Yamakura Iizuka mine, analyses by Waseda University laboratory.

The mines are worked as open pits by hand methods. At the Futase mine the overburden is 20 meters thick, and the ratio of overburden to thickness of the clay beds is 7:1. At the other mines this ratio is much smaller, the overburden averaging two to four meters in thickness. Operations are complicated at some of the mines by the large number of minor faults which occur. Part of the labor is supplied by local farmers, so clay production decreases during the seasons of planting and harvesting.

d. Production

Three-fourths of the clay is shipped in a raw state, but the numerous thin coal seams which alternate with the clay have led to the practice of precalcinization at or near some of the mines. This is effected by burning coal beneath a mixture of clay and coal for 40-50 days. About one ton of coal is required for 40 tons of clay. All of the production of the Torada Ito mine and part of the clay dug at the Akaike, Iizuka, Yamakura Iizuka, and Yamakura Shakanoo mines is precalcined. Coal mine dumps which have undergone spontaneous combustion also are dug occasionally.

Available production data for the Iizuka area, including both raw and burned clay, are given in Table 19. All of this production is used by factories in Kyushu for the manufacture of firebricks, and 90 percent is consumed within a 50-mile radius of the producing area. The Yawata iron foundry of Nittetsu Kogyo KK consumes 40 percent, and the factory of the Wake Taika Kogyo KK at Yawata, 35 percent. In the past, clay from the Iizuka area was mixed with high-aluminum shale from China and kibushi from the Seto area for the manufacture of firebricks, but Iwate clay is now substituted for the high-aluminum shale.

The selling prices are government-controlled. In early 1948 they were ¥200-900 a ton, the burned clays and the most highly refractory clays commanding the highest prices.

e. Costs

In February 1948 the cost of production at the various mines in the Iizuka area was ¥90-508 a ton. Variable faulting and thickness of overburden are local factors which influence production costs. The added expense of precalcinization at some of the mines also increases the range of costs. In general, the larger producers have a higher production per employee. The cost data are summarized in Table 18.

f. Reserves

Proven and probable reserves within the mine claims, as reported by the various mine owners are listed in Table Y. No data are available on possible reserves.

TABLE Y. - FIRE CLAY RESERVES IN IIZUKA AREA a/
(metric tons)

Mine	Proved	Probable
Futase	ND	500,000
Iizuka	15,000	20,000
Matsuo	ND	80,000
Sano	50,000	70,000
Taniguchi	ND	1,080,000
Torada (two mines)	ND	200,000
Tsubone	80,000	120,000
Yamakura (three mines)	345,000	ND
TOTAL	490,000	2,070,000

a/ No data on reserves for other mines in the area
ND: No data available

The accuracy of the assumptions and computations involved in estimating reserves is problematical. In addition, even though deposits are available, the extent of open pit operations in the area is limited by surrounding farm land. This condition sometimes occurs even within a mine claim.

3. Tsukinokawa Deposit

a. Location and Accessibility

The Tsukinokawa mine is at Shiraimen, Tsukinokawa-mura, Kita-Matsuura-gun, Nagasaki Prefecture, at an altitude of about 395 meters. It is at coordinates 1133.5-1280.2 on AMS L571 (Central Japan), scale 1:250,000, Sheet 44 (Sasebo), and on AMS L772 (Kyushu), scale 1:50,000, Sheet 4047-III (Hirado).

The deposit is about six kilometers southeast of the Tsukinokawa station over a poor road which becomes impassable in wet weather. The clay is transported from the mine to the railroad by truck.

b. History and Ownership

Apparently sporadic small-scale production from this deposit took place under several owners for about 20 years before Nittetsu Kogyo KK bought the property in late 1945. The deposit has been thoroughly studied by company engineers and geologists with a view to supplying fire clay for the company's Yawata iron foundry.

c. Geology and Mining Methods

The Tsukinokawa mine is located in the extreme northern part of the Hokusho coal field and in the trough of a broad, shallow, gently west-plunging syncline of late Tertiary sediments capped by Pleistocene basalt flows. Physiographically, the area is in the mature stage of dissection. The basalt has been eroded from most of the area surrounding the mine, but the mountain on which the mine is located is composed of basalt, and the fire clay has resulted from the surface weathering of the basalt. The deposit is located in a semi-enclosed valley with steep sides. A gradual transition takes place from the unaltered basalt below to the overlying products of residual weathering, and above the residual clays is slope wash which has undergone more complete alteration after deposition to form the best part of the deposit. No detailed study has been made of the clay minerals present.

The fire clay produced has a variety of colors, including white, gray, blue, yellow, and red. The contacts between the colors are irregular and variable, being sometimes gradual and sometimes sharp, but the red clays generally occur immediately above the unaltered basalt. Although the quality of the clays is lowered by their high rate of shrinkage, they have an average refractoriness of about SK 33 (1745°C) despite their high iron content. Representative analyses, as made by the Yawata laboratory of Nittetsu Kogyo KK, are:

TABLE 2. - REPRESENTATIVE ANALYSES OF TSUKINOKAWA CLAYS
(percent)

Color	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Ign Loss	Total	SK Value
Blue	42.60	38.53	2.65	0.94	1.34	13.62	99.68	31 (1680°C)
Gray	41.26	39.25	3.17	0.35	0.55	15.34	98.92	34 (1760°C)
White	41.60	40.42	1.74	0.40	0.55	15.20	99.91	34 (1760°C)
Pink	39.84	40.58	3.82	0.53	0.47	14.68	99.92	34 (1760°C)
Red	38.63	38.71	6.45	0.94	0.38	14.40	99.56	33 (1745°C)

The soil covering is about one meter thick. Hand methods are used to work the deposit as an open pit.

d. Production

Mine officials estimated the 1947 production at 6,000 tons. The Mining Bureau gives the 1948 figure as 5,975 tons. If unlimited railroad transportation to Yawata were available, the production probably would increase to 1,000 tons a month. No cost data are available.

e. Reserves

Proved reserves, as computed by company engineers, are 45,000 tons. This figure is probably reliable.

1. General

Hokkaido's need for an indigenous supply of fire clay, occasioned by the development of its industries, has been accentuated by the shortage of high-refractory clays in Japan since 1945. Significant production has failed to materialize from the two main prospects, the Chikubetsu and Yoshioka deposits, and most of the Hokkaido production has come from two small pits, the Numaushi and the Kubonai.

2. Yoshioka Deposit

a. Location and Accessibility

The Yoshioka fire clay is located in Yoshioka-mura, Matsumae-gun, Oshima-shicho, Hokkaido, at an altitude of 170 meters. It is at coordinates 744-2118 on AMS L561 (Northern Japan), scale 1:250,000, Sheet 48 (Hakodate), and on AMS L764 (Hokkaido), scale 1:50,000, Sheet 6171-II (Toshima Fukuyama). The outcrops are about four kilometers west of Yoshioka village via the Fukuyama highway. The road between the deposit and the village is in fair condition except for the portion from the deposit to Chogoro-gawa. This part of the road would require extensive repairs, estimated in February 1948 to cost ¥750,000, before it could accommodate trucks and horse-carts. Even after repair, heavy snows would prohibit truck traffic on the road between December and April, but horse-drawn sleds could operate throughout most of the winter. The cost of installing an aerial tramway between the outcrop and Yoshioka was estimated at ¥32,000,000 in February 1948. Transportation between Yoshioka and Hakodate, a distance of 80 kilometers, is available by train.

b. History and Ownership

For many years oil shale was known to exist in the area immediately west of Yoshioka. In July 1931, while studying the oil shale, Prof J. Takahashi of Tohoku University discovered the refractory qualities of the clay underlying the shale. Soon after the results of his studies became known, the Shinagawa Shirorenga KK purchased an area including the most promising outcrops of the refractory clay but made no immediate efforts to develop the prospect. Subsequent study of the adjacent area in 1940 disclosed promising outcrops of the clay on land owned by Yoshioka village, about one kilometer north of the property of the Shinagawa Shirorenga KK. Yoshioka village immediately signed a contract with the Narasaki Koun KK leasing mining rights of the clay for a 10-year period with the stipulation that the village be paid a royalty of 50 sen a ton. During February-May 1944, 690 tons of clay were produced. No further attention was directed to the Yoshioka fire clay until early 1948, when transportation difficulties seriously interfered with the supply of Iwate clay and utilization of the Chikubetsu clay was prevented by technical difficulties of extraction. Complete and detailed study of the Yoshioka area was then undertaken by Messrs K. Takase and H. Saito, with a view to supplying the Wanishi factory of the Nippon Seitetsu KK with a fire clay from Hokkaido.

c. Geology and Mining Methods

The general geology of the Yoshioka area is shown in Figure 15. Data on the character and attitude of the Paleozoic rocks are incomplete. The Tertiary strata strike northeast-southwest and dip 25-45°SE. Augite-andesite dikes have intruded the Tertiary strata, and andesite flows followed the intrusion of the dike rocks.

The Tertiary strata of the area were studied by Prof T. Fukutomi, Hokkaido University, in 1930. He and Prof Takahashi differ somewhat in their interpretations of the Tertiary section in the area. Prof Fukutomi assigns the 1,690 meters of strata which he found, including three sets of alternating shale and tuff beds, to the late Pliocene. Prof Takahashi found two sets of alternating shale and tuff beds, with an aggregate thickness of 760 meters, and decided they were early Miocene in age.

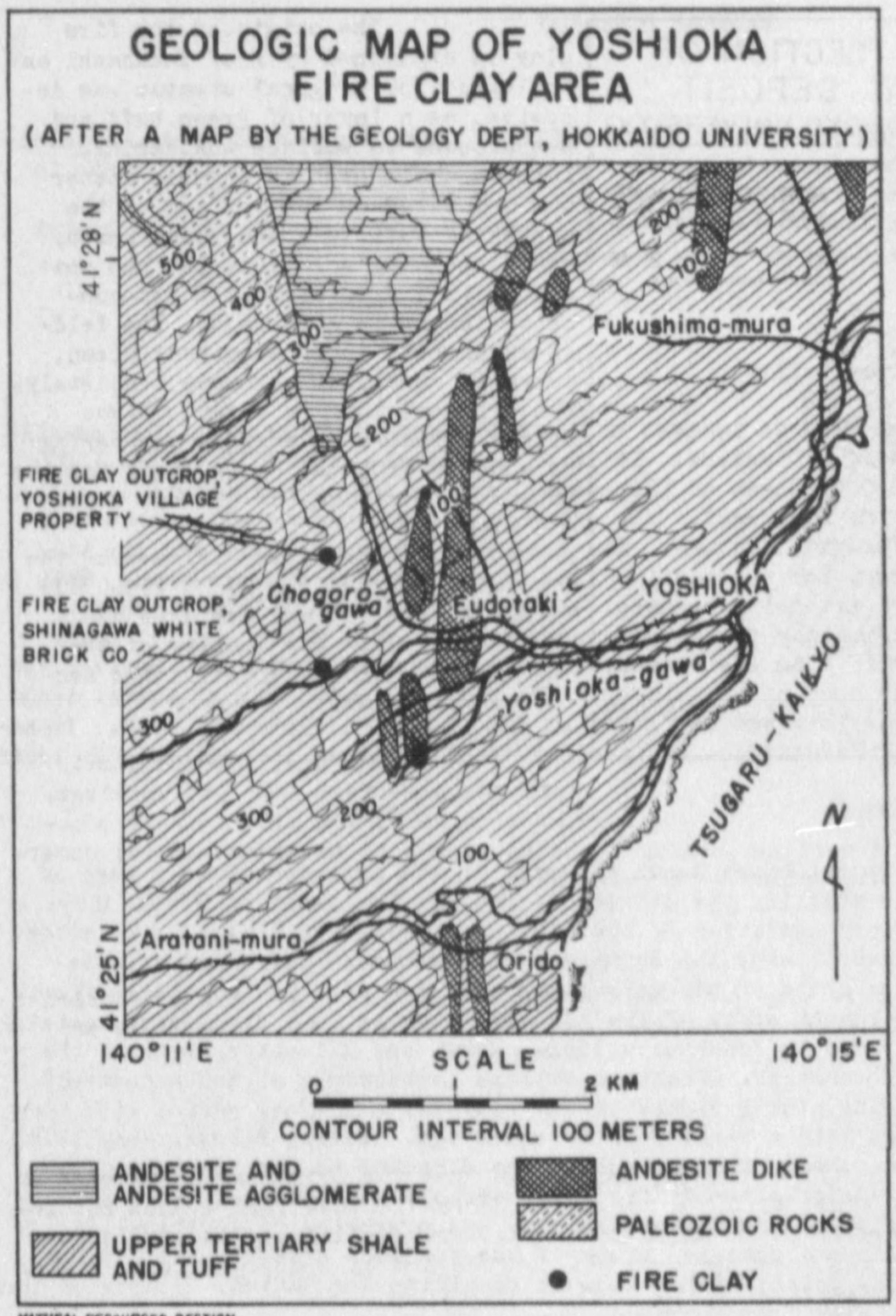


Figure 15

The lower shale bed of Prof Takahashi's section includes the fire clay. It occurs beneath a stratum of oil shale, which ranges in thickness from one to two meters, and above a layer of green tuff, as shown in the cross section (Figure 16). Analyses of the samples indicated in Figure 16 are given in Table AA.

The oil shale (A) is brownish-black and contains about one percent soluble organic matter, together with much humus. A portion of the shale, ranging in thickness from 2 to 10 centimeters, yields an oil return up to 10 percent. The fire clay (B) is brownish-black when wet and gray when dry. It has a greasy feel and occasional iron oxide stains along fracture planes. A petrographic study of the rock by Prof Takahashi revealed an agglomeratic texture with brownish stains between the fragments. Individual fragments are completely altered to an amorphous kaolinite-like mineral, but andesine and oligoclase crystals are clearly discernible. The partially altered green tuff (C) consists of plagioclase crystals, mostly andesine, in a matrix of ferric oxides. The green tuff (D) has hyalopilitic texture and has been intensely chloritized. Accessory minerals are leucoxene and epidote.

TABLE AA. - TYPICAL ANALYSES OF YOSHIOKA STRATA
(percent)

Sample	SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	MnO	TiO_2	Ign Loss	Total
Oil shale	52.41	20.04	2.78	a/	1.92	1.81	0.71	0.01	a/	0.57	19.65	99.89
Fire clay	48.96	25.02	4.73	18.47	2.63	2.98	2.24	0.27	0.04	1.03	8.48	100.33b/
Partially altered green tuff	48.96	30.62	4.04	1.34	1.10	0.97	1.00	0.09	a/	1.02	11.14	100.28
Green tuff	49.95	34.24	3.19	a/	0.01	0.93	0.92	0.42	a/	0.64	12.73	100.05

a/ Not included in analysis
b/ This column is in error but is reproduced as it appeared in the original data.

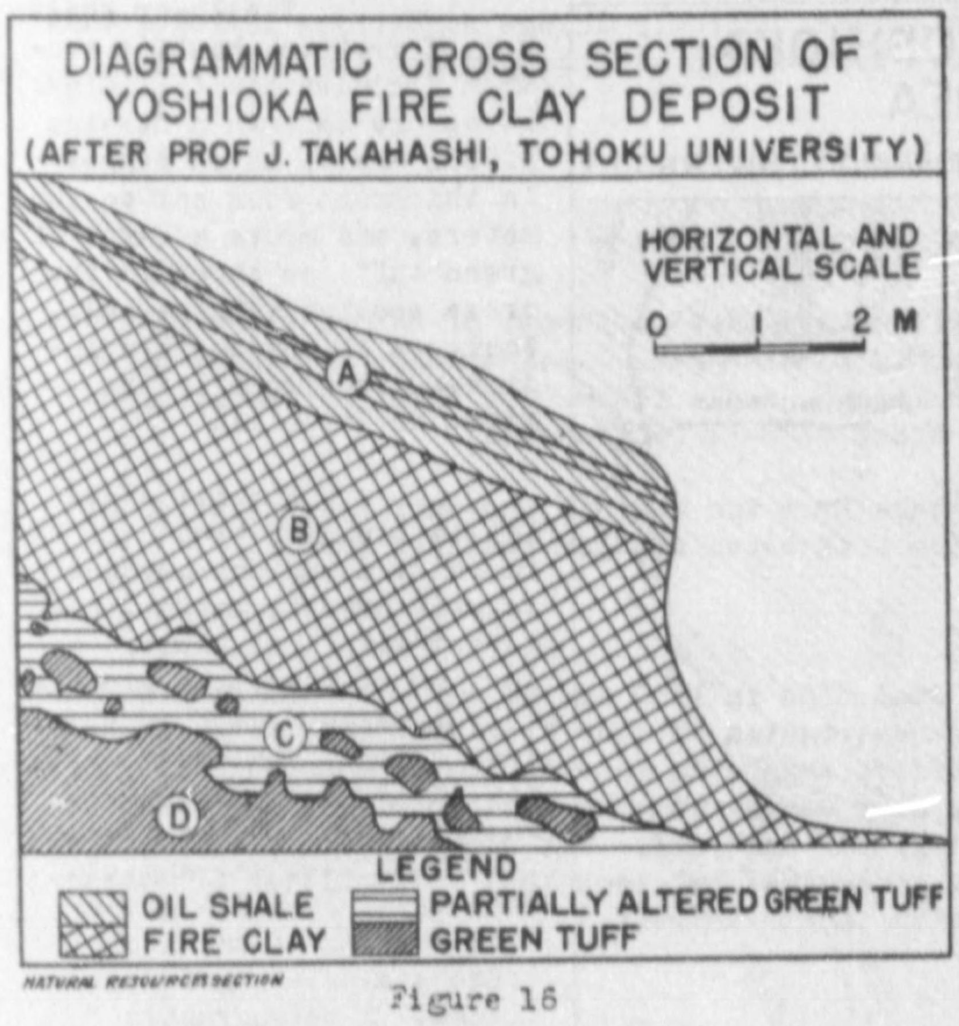


Figure 16

The origin of the fire clay is explained by Prof Takahashi as follows: The original stratum was deposited as a layer of green tuff and was exposed to surface weathering. Later a shale high in organic matter was deposited on the surface of the weathered tuff in a sea coast marsh, and descending solutions leached most of the iron from stratum (B) and concentrated it in stratum (C). The feldspars of both zones were kaolinized, those in stratum (B) the more completely. The original tuff in stratum (D) was little affected by surface weathering; no special explanation is given for the intense chloritization of this zone.

The refractoriness of the fire clay ranges from SK 30 (1650°C) to SK 34 (1760°C) and averages about SK 32 (1700°C). The quality of the clay is further described in the section on reserves.

The small production to date has come from open pit workings, but because of the dip of the productive strata (25-45°), dip-slope open pit mining would soon have to be abandoned for underground methods if large-scale production were undertaken.

d. Production

Only 690 tons of fire clay have been produced in this area. All production came from the property owned by Yoshioka village, and all occurred between February and May 1944.

e. Costs

In February 1948 probable cost of production from the Shinagawa Shirorenga KK land was reliably estimated at about ¥1,300 a ton, FOB Yoshioka. This figure does not include the investment in road repair which would be a necessary preliminary to any large-scale production. These costs are based on open pit methods and of course would be higher if underground methods were necessary.

f. Reserves

Proved and probable reserves at the Shinagawa Shirorenga KK property are 20,000 and 300,000 metric tons, respectively. The clay averages SK 32 (1700°C) and is fairly uniform in quality. Composition, in percent, of the best sample tested by Prof Takahashi was as follows:

SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	TiO_2	Na_2O	K_2O	Ign Loss	Total
49.95	34.24	0.19	0.01	0.93	0.64	0.92	0.42	12.73	100.03

Clay from the Yoshioka village property is less uniform in quality and has an average SK value of only 28 (1615°C). The clay body is roughly lenticular in shape. The area between the two properties has not been studied in detail, but it appears probable that the productive beds are from the same horizon. The amount of the reserves on the village property is unknown, but it is believed to be substantially smaller than the Shinagawa reserves.

Development of this deposit appears unlikely unless conditions indicate that the availability of a fire clay indigenous to Hokkaido will compensate for the large initial investment required.

3. Chikubetsu Deposit

a. Location and Accessibility

The Chikubetsu mine is 15 kilometers east-northeast of Haboro at an altitude of about 100 meters. It is in Haboro-machi, Tomamae-gun, Rumoi-shicho, Hokkaido, at coordinates 905-2072 on AMS L561 (Northern Japan), scale 1:250,000, Sheet 27 (Haboro), and on AMS L764 (Hokkaido), scale 1:50,000, Sheet 6480-II (Chikubetsu).

By railroad it is 17 kilometers from the mine to the Chikubetsu station of the Haboro Line and 65 kilometers from the Chikubetsu station south to Rumoi.

b. History and Ownership

Chikubetsu was opened as a coal mine in 1940 and is owned by the Haboro Tanko Kogyo KK. Early in 1944, when the transportation of clay from the Iwate mine was becoming a problem, and when a concerted effort was being made to locate a good-quality fire clay deposit in Hokkaido, samples of the clay underlying the coal seam were submitted to the Hokkaido Industrial Research Laboratory for analysis. The clay was found to have good refractory qualities, and production was attempted, but technical difficulties of extraction have precluded large-scale utilization of the deposit.

c. Geology and Mining Methods

The geology of the mine area is shown in Figure 17. The rocks exposed are all sedimentary, ranging in age from late Cretaceous to late Miocene and folded into a series of symmetrical anticlines and synclines which strike north-northwest. The Chikubetsu anticline occurs at the center of the mine area. Striking along the axis of this anticline is the Chikubetsu fault, a normal fault dipping about 80°E, with displacements up to 250 meters. The Chikubetsu fault is one of a set of strike faults which occurs in the area. Another set, approximately dip faults, has lesser displacements. The best clay reserves occur on the northeast limb of the Chikubetsu anticline in the Haboro formation, as indicated in the columnar and cross sections (Figure 17).

The fire clay beds have an average dip of 30° and occur beneath a coal seam which has an average thickness of about four meters. The coal is subbituminous in rank and is subject to weathering and spontaneous combustion. The thickness of clay beneath the coal is variable, averaging seven or eight meters. However, only the two meters directly beneath the coal seam consist of fire clay. Although SK values of the clay are somewhat inconsistent, tests made to date indicate that these two meters have an average refractoriness of SK 32 (1700°C), being most refractory nearest the coal. The clay is light grayish-brown in color, poor in plasticity, and chalk-like in appearance when dry. Linear air shrinkage for four samples of the clay averaged 3.12 percent. No data are available on clay minerals present. Two representative analyses, made in 1946 by the Hokkaido Industrial Research Laboratory, are shown:

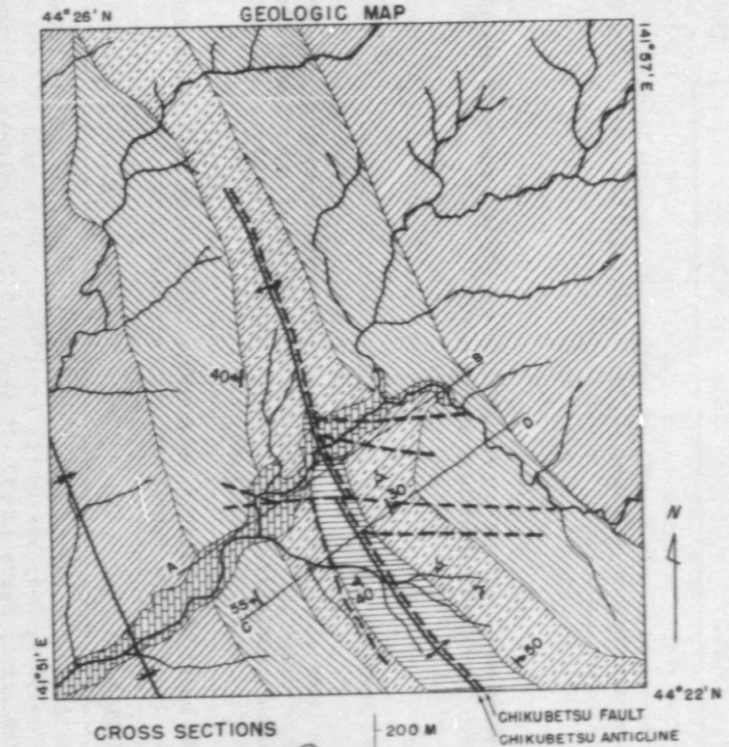
TABLE AB. - REPRESENTATIVE ANALYSES OF CHIKUBETSU CLAY
(percent)

Sample	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Ign Loss	Total	SK Value
A	48.54	34.09	1.89	1.42	0.28	12.92	99.12	34 (1760°C)
B	54.18	33.58	1.74	0.68	0.12	9.24	99.54	30 (1650°C)

CHIKUBETSU MINE AREA

(AFTER GEOLOGIC MAPS FURNISHED BY THE HABORO COAL MINING CO AND BY THE NITTETSU MINING CO)

GEOLOGIC MAP



COLUMNAR SECTION

ERA	PERIOD	EPOCH	FORMATION	LITHOLOGY
CENOZOIC	QUATERNARY		ALLUVIUM DILUVIUM	SANDS, GRAVELS, CLAYS
	TERTIARY	LOWER AND MIDDLE MIOCENE	KOTAMBETSU FORMATION	ALTERNATING SANDSTONES, SHALES, AND CONGLOMERATES.
			CHIKUBETSU FORMATION	ARENACEOUS SHALES IN LOWER SECTION GRADE THROUGH SANDSTONES AND SHALES TO AN EXTREME UPPER SECTION OF ALTERNATING SANDSTONES, SHALES, AND CONGLOMERATES.
			HABORO FORMATION	LOWER SECTION MAINLY TUFF AND SANDSTONE. UPPER PART CONTAINS SANDSTONES AND SHALES INTERCALATED WITH COAL MEASURE WORKED AT THE CHIKUBETSU MINE. FIRE CLAY UNDERLIES COAL SEAM. EXTREME UPPER SECTION IS ARGILLACEOUS SANDSTONE.
MESOZOIC	UPPER CRETACEOUS		HOBETSU SHALE (UPPER AMMONITE BEDS)	ALTERNATING SANDSTONES AND SHALES WITH THIN, UNWORKABLE COAL SEAMS.

APPROXIMATE VERTICAL SCALE: 0 250 500 M

Figure 17

The transition from the fire clay to the underlying clay is sharp. As the refractoriness drops off rapidly to SK 26 (1595°C) and lower values, the clay becomes plastic and takes on the property of strong swelling. Because of the latter property, the clay is described as bentonitic, although no laboratory study of it has been made. Not only is this clay valueless as fire clay, but its strong tendency to swell has made the working of the overlying fire clay uneconomical. Coal mining operations also are complicated by the swelling. Timbers must be replaced frequently. Where the coal has just been mined out, not uncommonly the floor of the drift will be raised one foot in 24 hours by the swelling of the underlying clay. Thus further attempts to develop the Chikubetsu fire clay seem improbable.

d. Production

Production data for 1944-48, as obtained from the mine officials, are given:

TABLE AC. - PRODUCTION OF CHIKUBETSU CLAY, 1944-48
(metric tons)

Period	Amount
Jul-Dec 44	9
Jan-Jun 45	587
Jul-Dec 45	65
Jan-Jun 46	0
Jul-Dec 46	10
Jan-Jun 47	86
Jul-Dec 47	17
Jan-Jun 48	8
TOTAL	782

This production was consumed entirely by factories within Hokkaido. Average selling price, in yen per ton, varied as follows: Jul 44-Jun 46, 74; Jul 46-Jun 47, 550; Jul-Aug 47, 850; Oct 47-Jun 48, 1,120.

e. Reserves

Proved reserves are given by mine officials as 590,000 metric tons; possible reserves, 4,800,000 tons. These data probably are reliable.

4. Numaushi Deposit

a. Location and Accessibility

The Numaushi fire clay is located in Horokanai-mura, Uryu-gun, Sorachi-shicho, Hokkaido, at an altitude of about 180 meters (Figure 18). It is at coordinates 925.6-2422.7 on AMS L561 (Northern Japan), scale 1:250,000, Sheet 36 (Asahigawa), and on AMS L764 (Hokkaido), scale 1:50,000, Sheet 6578-IV (Kami-etambetsu).

The clay was moved, by truck or horse-cart, about three kilometers over fair roads from the deposit to the Numaushi station of the Horokanai Line.

b. History and Ownership

The clay was first noticed in a road cut about 1930. In 1940 Mr Izawa of Hakodate, who has other business interests in the area, submitted a sample of the clay to the Muroran factory of the Nippon Seitetsu KK. It was found to be suitable for the manufacture of firebricks, and production from the deposit was begun in 1942.

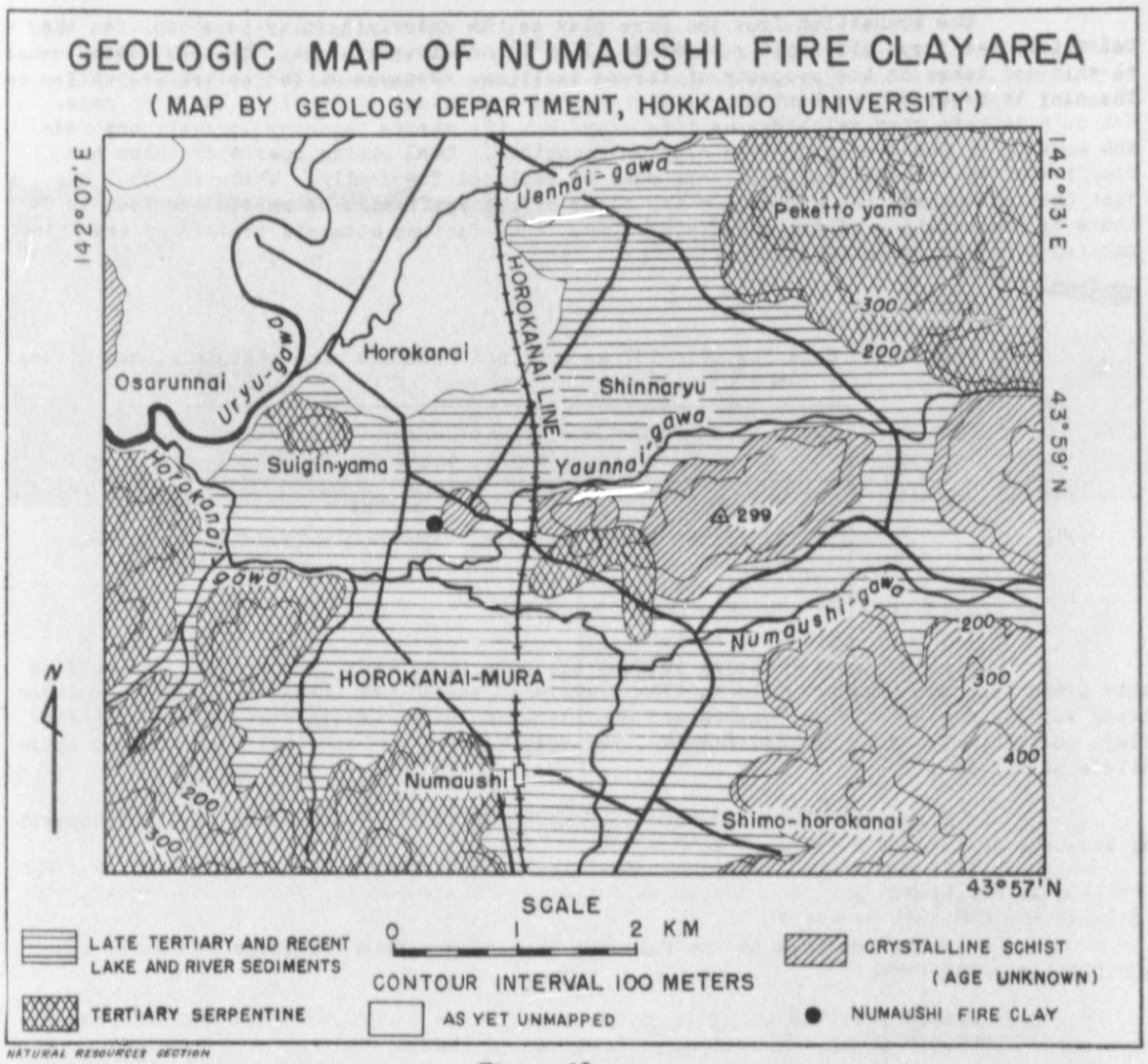


Figure 18

c. Geology and Mining Methods

The Numaushi deposit is found on a small plain which is surrounded by mountains (Figure 18). The clay was probably deposited as a rhyolitic tuff in late Tertiary time and exposed to surface alteration before being covered by the waters of a Quaternary lake. Lake and river sediments veneer the clay to a depth of one or two meters. Leucocratic dikes which cut the nearby Tertiary serpentine present the possibility that hydrothermal alteration may have played a role in the transformation of the original tuff. The Numaushi fire clay ranges from SK 31 (1680°C) to SK 34 (1760°C), is nonplastic, and is gray in color. The following analysis, in percent, was made by the Hokkaido Industrial Research Laboratory:

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Ign Loss	Total	SK Value
50.04	32.01	1.89	1.42	0.28	12.94	98.58	34 (1760°C)

The deposit was worked as an open pit by hand methods (Figure 19). The clay was loaded into ore cars which ran on tracks at the base of the cut. The cars were pushed to the road, where the clay was transferred to trucks or horse-carts for transportation to Numaushi station.

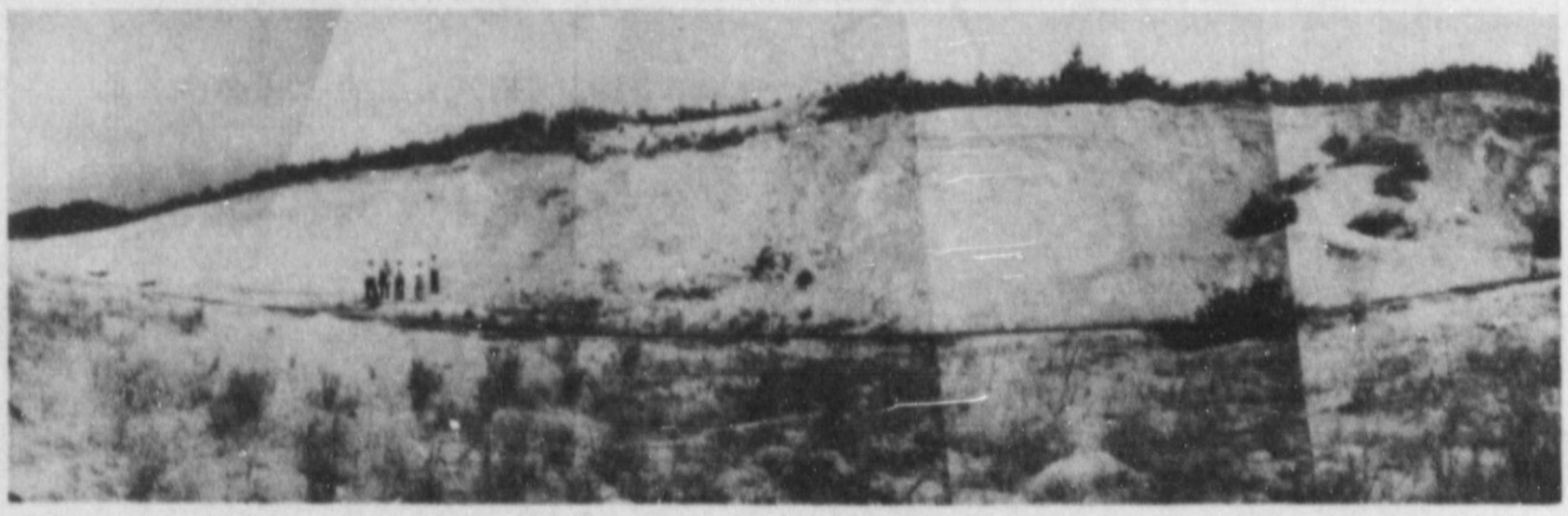


Figure 19. - Numaushi clay pit. Horokanai-mura, Uryu-gun, Hokkaido, July 1948.

d. Production

Total production during 1942-47 was more than 8,000 tons. About one-half of this production was bought by the Muroran factory of the Nippon Seitetsu KK, the remainder being sold to other Hokkaido consumers. A continuous demand exists for the Numaushi fire clay, particularly by Nippon Seitetsu KK, and only lack of transportation has closed operations at the pit.

In July 1948 about 200 tons of Numaushi fire clay were available for shipment at Numaushi station at a price of ¥650 a ton.

e. Reserves

Possible reserves of the Numaushi fire clay within the Izawa claim are about 100,000 tons.

5. Kubonai Deposit

a. Location and Accessibility

The Kubonai fire clay is located in Sobetsu-mura, Usu-gun, Iburi-shicho, Hokkaido, at an altitude of about 200 meters (Figure 20). It is at coordinates 818.2-2255.4 on AMS L561 (Northern Japan), scale 1:250,000, Sheet 42 (Muroran), and on AMS L764 (Hokkaido), scale 1:50,000, Sheet 6274-I (Abuta).

The clay is transported by horse-cart two kilometers over a poor road from the deposit to the Naka-kubonai station of the Jukan railroad.

b. History and Ownership

Local farmers sent a sample of the clay to Mr Izawa of Hakodate in 1941. Analysis proved that the material could be used for the manufacture of firebricks, and Mr Izawa has worked the deposit since 1942.

c. Geology and Mining Methods

The Kubonai fire clay was formed by the hydrothermal and surface alteration of a late Tertiary quartz-porphyry. An analysis of the clay in percent, made by the Hokkaido Industrial Research Laboratory, follows:

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Ign Loss	Total	SK Value
70.44	24.67	0.57	0.16	Trace	3.96	99.80	29 (1640°C)

The mine is worked as an open pit by hand methods. It employed seven men in July 1948.

d. Production

Since 1942, production has totaled about 3,000 tons, all of which has gone to factories in the Muroran and Kuruyama areas. In the summer of 1948 production was averaging about 200 tons a month. Production was held at this level by a shortage of railroad cars. Operations are suspended during the winter months.

No data are available on costs or on reserves.

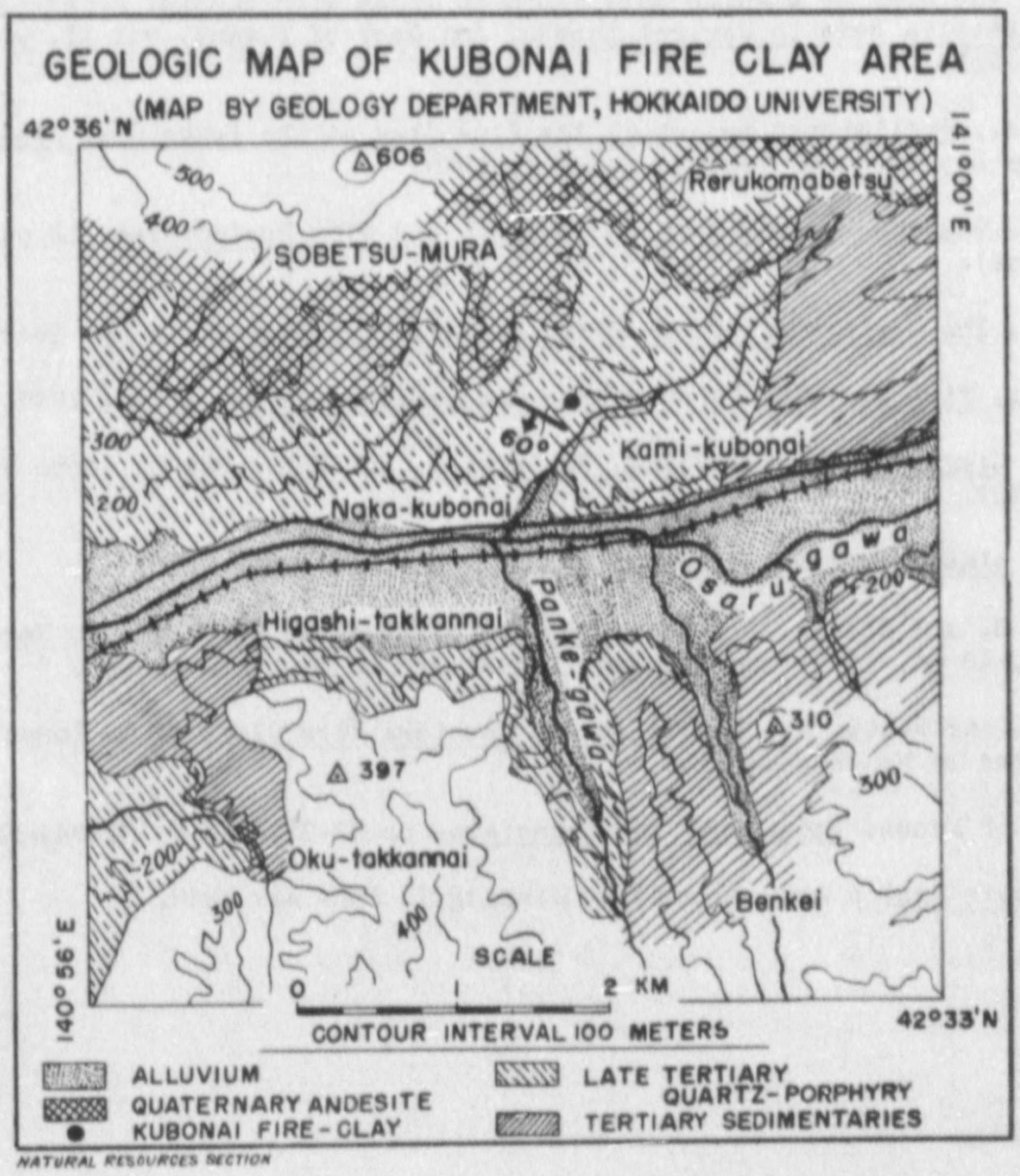


Figure 20

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GLOSSARY

1. Conversion Factors

Metric Units		English Units
1 metric ton	=	1.102 short tons 2,204.6 pounds
1 kilogram	=	2.205 pounds
1 gram	=	0.035 ounce

Metric Units		English Units
1 kilometer	=	0.621 mile
1 meter	=	3.281 feet
1 centimeter	=	0.394 inch
1 liter	=	2.113 pints

2. Japanese Terms

-gawa	river
-gun	county, territorial division of a prefecture
Kabushiki Kaisha (KK)	Company, Limited
-kawa	river
koku	5.1189 bushels or 6.3704 cubic feet
-machi	township, town, or street
-mura	village, township
-san	mountain
-shi	city
-shicho	subprefecture (Hokkaido)
-wan	bay
-yama	mountain

TABLE 1.- JAPANESE PRODUCTION OF FIRE CLAY, 1925-48
(metric tons)

Year	Flint-Type Fire Clay a/	Plastic-Type Fire Clay b/	Total Fire Clay Production
1925	8,500	100,000	108,500
1926	9,500	100,000	109,500
1927	10,000	100,000	110,000
1928	10,348	110,000	120,348
1929	16,237	120,000	136,237
1930	28,400	120,000	148,400
1931	27,782	120,000	147,782
1932	25,295	230,000	255,295
1933	19,680	350,000	369,680
1934	28,820	350,000	378,820
1935	39,140	350,000	389,140
1936	40,273	350,000	390,273
1937	33,666	350,000	383,666
1938	73,743	400,000	473,743
1939	88,617	550,000	638,617
1940	82,494	500,000	582,494
1941	98,342	600,000	698,342
1942	109,412	500,000	609,412
1943	134,289	500,000	634,289
1944	199,270	370,000	569,270
1945	112,814	88,636	201,450
1946	31,492	90,773	122,265
1947	55,167	123,132	178,299
1948	85,499	153,803	239,302
TOTAL	1,368,780	6,626,344	7,995,124

a/ Source: Individual mine records
b/ Source: 1925-44, estimates by Ceramic Section, Chemical Bureau, Ministry of International Trade and Industry; 1945-47, individual mine owners; 1948, Mining Bureau, Ministry of International Trade and Industry.

TABLE 2.- JAPANESE IMPORTS OF HIGH-ALUMINUM SHALE, 1930-44
(metric tons)

Year	Imports from Korea and Manchuria	Imports from North China	Total Imports
1930	37,156	0	37,156
1931	23,173	0	23,173
1932	43,344	0	43,344
1933	85,106	0	85,106
1934	107,186	0	107,186
1935	132,516	3,690	136,206
1936	140,238	13,360	153,598
1937	167,986	36,750	204,736
1938	273,459	57,750	331,209
1939	289,685	73,590	363,275
1940	212,700	152,162	364,862
1941	137,900	181,900	319,800
1942	119,100	198,358	317,458
1943	96,321	183,150	279,471
1944	50,972	276,372	327,344
TOTAL	1,916,842	1,177,082	3,093,924

SOURCE: Ceramic Section, Chemical Bureau, Ministry of International Trade and Industry.

TABLE 3.- REPRESENTATIVE ANALYSES OF AICHI-GIFU CLAYS
(percent)

Item	Gaerome					Kibushi				
	Tokiguchi District, Washed a/	Hara District		Fujioka District d/		Tokiguchi District a/	Tajimi District e/	Yagusa District e/	Sanago District e/	Seto District e/
		Unwashed b/	Washed c/	Unwashed	Washed					
SiO_2	49.28	84.53	46.90	83.32	51.48	65.61	52.20	67.26	47.48	50.42
Al_2O_3	36.17	11.15	37.22	9.77	34.57	17.14	33.22	18.77	33.96	33.11
Fe_2O_3	0.48	0.47	0.37	0.81	0.72	1.53	1.55	1.90	2.62	1.57
CaO	0.18	0.09	0.65	f/	0.46	0.22	f/	1.30	0.08	0.24
MgO	0.06	0.54	f/	f/	0.23	0.20	f/	0.89	0.23	0.44
K_2O	0.14	f/	f/	f/	f/	0.80	f/	f/	0.53	0.80
Na_2O	0.14	f/	f/	f/	f/	0.24	f/	f/	f/	0.28
Ign loss	13.56	3.51	14.42	3.58	11.41	14.33	11.41	8.28	14.94	13.20
TOTAL	100.01	100.29	100.56	97.48	98.87	100.57	98.38	98.40	99.84	100.06
SK value	f/	f/	f/	f/	f/	f/	33 (1745°C)	30 (1650°C)	34 (1760°C)	33 (1745°C)

a/ Analysis by Gifu Prefecture Ceramic Investigating Laboratory
b/ Analyst unknown
c/ Analysis by Toyo Ceramic Co Ltd
d/ Analysis by Nippon Toki Laboratory
e/ Analysis by Nippon Kokan Laboratory
f/ No analysis made

TABLE 4.- CLAY PRODUCTION COSTS IN AICHI AND GIFU PREFECTURES, 1925 - 48 a/
(yen per ton)

Year	Aichi Prefecture			Gifu Prefecture		
	Seto District	Fujioka and Sanage Districts	Yagusa District	Hara District	Tokiguchi District	Tajimi District
1925	2-3	5-7	ND	ND	ND	ND
1930	3-4	5-6	2-3	ND	ND	ND
1935	3-4	4-6	2-3	ND	ND	2.5-3.5
1940	4-6	5-9	4.5-5.5	ND	ND	4.5-5.5
1941	4-9	5-9	5-11	ND	ND	5-7
1942	4-9	5.5-9.5	5-13	ND	ND	5-8
1943	6-21	6.5-23	8-17	ND	ND	6-15
1944	10-34	12-38	12-22	ND	ND	10-17
Sep 1945	20-50	25-55	25-70	ND	ND	20-40
Jan 1947	60-180	110-220	80-190	ND	ND	80-170
Feb-Mar 1948	135-409	305-747	300-526	ND	459	185-255

a/ Costs given for years prior to 1945 are considered to be reliable estimates.
ND: No data available
SOURCE: Individual mine owners

TABLE 5.- GAEROME WASHING PLANTS IN AICHI AND GIFU PREFECTURES, 1948

Washing Plant	Owner	Production of Washed Gaerome (MT)
Aichi Prefecture		
Seto district		
Akateu (Fujii)	Fujii Kogyo KK	2,092
Higashiyama	ND	60
Ito	Ito, Takeshi	40
Kajita	Kajita, S.	20
Katayama	ND	36
Kawaji	Kawaji, Shimasaburo	425
Shinagawa Akateu	Shinagawa Shirorenga KK	213
Subtotal		2,886
Fujioka district		
Fujioka	Fujii Kogyo KK	4,560
Mitsukuri	Kyoritsu Togyo Genryo KK	1,012
Yamanaga	Nagai, Matsuo	270
Yamauchi	Yamauchi, Masuichi	645
Subtotal		6,487
TOTAL		9,373
Gifu Prefecture		
Hara district		
Maruhara	ND	346
Maruhei	ND	206
Maruko	Yoshizura, Teruaki	1,294
Sone	Sone, Shozo	1,533
Yamahei	Kasugai, Fumio	429
Subtotal		3,808
Tokiguchi district		
Fukazawa	Kato, Kyuemon	482
Gedo	Tsuchimoto, Eikichi	1,702
Higashi-Jimon	Terazawa, Koso	669
Jimon	Tsuchimoto, Kumpei	2,725
Nishiyama	Suzuki, Sadayoshi	4,127
Okumura	Okumura, Toshizo	1,443
Sawabora	Tsuchimoto, Hanjiro	980
Suwa	Tsuchimoto, Tetsuzo	963
Tokiguchi	Kyoritsu Togyo Genryo KK	616
Torideyama	Terazawa, Ryoichi	313
Wakeyama	Kato, Shoroku	334
Subtotal		14,354
TOTAL		18,162
GRAND TOTAL		27,535

ND: No data available
SOURCE: Mining Bureau, Ministry of International Trade and Industry.

TABLE 6.- GAEROME WASHING COSTS IN AICHI AND GIFU PREFECTURES

Washing Plant	Period	Washing Costs (yen per ton of washed clay)					
		Labor	Power	Tools and Materials	Staff a/	Miscellaneous	Total
Akateu (Fujii)	1947 Avg	345	31	52	299	59	786
Kawaji	Jan-Feb 1948	995	57	1,800	840	490	4,182 b/
Mitsukuri	Jan-Feb 1948	680	60	680	60	280	1,760
Sone	1947 Avg	976	18	1,232	463	203	2,892
11 Plants in Tokiguchi district (average)	1947 Avg	410	15	600	210	0	1,235

a/ Office and technical personnel
b/ Includes total cost of washing, with no allowance made for returns from silica sand production.
SOURCE: Washing plant managers

TABLE 7. - COSTS OF CLAY PRODUCTION BY MINES IN SETO DISTRICT

Mine	Present Owner	Year Mining Began	Average Overburden Thickness (meters)	Production Costs, March 1948 (yen per MT)				Employees, March 1948			Wages (yen per day)		Production, 1947			Average Production Per Employee, 1947 (metric tons)
				Overburden Stripping	Other Mining Costs		Total	Men	Women	Total	Men	Women	Gaerome	Kibushi	Total	
					Direct	Indirect										
Akatsu (Fujii)	Fujii Kogyo KK	1915	ND	12	190	84	286	18	0	18	55-157.5	NA	6,942	1,697	8,639	479.9
Daigaku	Kato, Shinichiro	1930	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	671	671	ND
Ichiyanagi	Ichiyanagi, Shoemon	1948	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	0	0	ND
Kashiba	Shibata, Yoshijiro	1946	12.0	ND	270	50	320	4	0	4	120	NA	NA	500	500	125.0
Kawaji	Kawaji, Shinsaburo	1946	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0	0	0	ND
Kasen	Kato, Masayoshi	1914	ND	ND	300	109	409	7	0	7	140-180	NA	846	0	846	ND
Kogumi	Seto Tojiki Kogyo Kumiai	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0	0	0	ND
Maruhachi	Miura, Sutesaburo	1935	ND	ND	ND	ND	ND	2	1	3	230	70	0	ND	0	ND
Maruichi	Kato, Koichi	1920	ND	ND	ND	ND	ND	2	0	2	150	NA	NA	150	150	75.0
Marukatsu	Kato, Katsuichi	1939	ND	ND	ND	ND	ND	3	0	3	100	NA	NA	324	324	108.0
Maruni	Misuno, Itaro	1934	20.0	ND	ND	ND	ND	2	0	2	150	NA	NA	739	739	369.5
Marutate	Adachi, Koichiro	1937	ND	100	50	100	250	ND	ND	ND	ND	ND	430	1,300	1,730	ND
Maruyama	Asaoka, Setichi	1931	16.0	ND	210	80	290	6	0	6	160	NA	NA	ND	0	ND
Mitsui Misuno	Mitsui Kozan KK	1922	ND	60	35	40	135	1	0	1	100	NA	NA	683	683	683.0
Nakashima	Nakashima, Tugoro	1943	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	0	ND
Shinagawa Akatsu	Shinagawa Shirorenga KK	1917	30.0	155	59	86	300	4	1	5	100-140	60	1,200	ND	1,200	ND
Shinagawa Shinano	Shinagawa Shirorenga KK	1944	13.5	77	15	152	244	34	2	36	100-140	50-80	NA	4,905	4,905	136.2
Shinano a/	Shinano Todo KK	1939	20.0	ND	ND	ND	ND	11	0	11	150	NA	450	205	655	59.5
Toa	Toa Kogyo KK	1942	ND	ND	20	25	45	1	0	1	ND	NA	NA	125	125	125.0
Toho (Sangyo)	Mori, Saburo	1941	6.0	ND	ND	ND	ND	3	0	3	150	NA	NA	422	422	140.6
Tomida	Tomida, Sokichi	1947	ND	ND	ND	ND	ND	4	0	4	200	NA	NA	ND	0	ND
Ugai	Ugai, Kenji	1936	ND	ND	ND	ND	ND	6	2	8	200-350	100-110	NA	417	417	52.1

a/ Baba, Yatoko, and Higashiyama pits.
NA: Not applicable
ND: No data available
SOURCE: Individual mine owners

TABLE 8. - COSTS OF CLAY PRODUCTION BY MINES IN FUJIOKA AND SANAGE DISTRICTS

Mine	Present Owner	Year Mining Began	Average Overburden Thickness (meters)	Production Costs, March 1948 (yen per ton)				Employees, March 1948			Wages (yen per day)		Production, 1947			Average Production Per Employee, 1947 (metric tons)
				Overburden Stripping	Other Mining Costs		Total	Men	Women	Total	Men	Women	Gaerome	Kibushi	Total	
					Direct	Indirect										
Aichi Nendo	Aichi Nendo Kogyo KK	1939	12.0	300	120	189	609	21	8	29	100-180	60-80	NA	1,409	1,409	48.5
Ejiri	Ejiri, Yoshi	1945	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	360	360	ND
Fujioka	Fujii Kogyo KK	1938	ND	141	98	66	305	38	2	40	ND	ND	14,067	NA	14,067	351.6
Hananoto	Otsuka, Kumakichi	1944	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	574	574	ND
Mifune (Nihon Rutsubo)	Hirabayashi, Kakuemon	1925	ND	288	70	119	477	29	5	34	110	57	NA	2,025	2,025	59.5
Mikawa	Osaka Yogyo KK	1944	10.0	ND	ND	ND	ND	14	1	15	270	140	NA	0	0	NA
Sansei (Mitsuboshi)	Tokyo Shibaura Denki KK	1917	21.5	374	48	319	747	63	11	74	193-244	70-100	NA	10,163	10,163	137.3
Tokai Sanage	Tokai Kogyo KK	1942	13.0	210	299	182	691	14	2	16	100-140	70-100	NA	340	340	21.2
Yamanaga	Nagai, Matsuo	1935	10.0	ND	260	114	374	7	0	7	130-185	NA	1,345	0	1,345	192.1
Yamanouchi	Yamanouchi, Masuichi	1938	ND	ND	ND	ND	500	24	2	26	195	120	ND	NA	ND	ND

NA: Not applicable
ND: No data available
SOURCE: Individual mine owners

TABLE 9.- COSTS OF CLAY PRODUCTION BY MINES IN YAGUSA DISTRICT

Mine	Present Owner	Year Mining Began	Average Overburden Thickness (meters)	Production Costs, March 1948 (yen per ton)				Employees, March 1948			Wages (yen per day)		Production, 1947, Kibushi	Average Production Per Employee, 1947 (metric tons)
				Overburden Stripping	Other Mining Costs: Direct	Other Mining Costs: Indirect	Total	Men	Women	Total	Men	Women		
Hotoku	Inoue, Matsugoro	1925	30	100	310	116	526	30	1	31	120-170	ND	1,525	49.2
Mukaida	Kyoritsu Genryo KK	1939	8	50	70	180	300	26	0	26	100-130	NA	2,110	81.1
Shibo	Kato, Kyohei	1935	ND	95	172	97	364	25	2	27	ND	80-140	1,890	70.0
Shinagawa Yagusa	Shinagawa Shiroreaga KK	1939	ND	ND	ND	ND	ND	24	0	24	70-130	NA	500	20.8
Tokai Yagusa	Tokai Kogyo KK	1931	20	ND	ND	ND	ND	23	5	28	90-140	60-85	2,847	101.7

NA: Not applicable ND: No data available SOURCE: Individual mine owners

TABLE 10.- COSTS OF CLAY PRODUCTION BY MINES IN HARA DISTRICT

Mine	Present Owner	Year Mining Began	Average Overburden Thickness (meters)	Employees, March 1948			Wages (yen per day)		Production, 1947			Average Production Per Employee, 1947 (metric tons)
				Men	Women	Total	Men	Women	Gaerone	Kibushi	Total	
Kaneichi	Maruse, Masataka	1933	ND	11	0	11	150	NA	2,530	NA	2,530	230.0
Maruse	Hara Todo Sangyo KK	1932	ND	16	1	17	150	100	270	NA	270	15.8
Maruhachi	Hara Todo Sangyo KK	1927	ND	9	3	12	150	100	ND	NA	ND	ND
Maruhara	Hara Todo Sangyo KK	1930	32	13	2	15	150	100	4,330	ND	4,330	288.6
Maruichi	Akechi Taika KK	1933	6	11	2	13	150	100	970	ND	970	74.6
Marusan	Kato, Ryozaemon	1907	ND	15	0	15	150	NA	1,052	NA	1,052	70.1
Marunaka	Ito, Junichi	1913	37	6	3	9	150	100	883	NA	883	98.1
Marumi	Hara Todo Sangyo KK	1926	ND	16	0	16	150	NA	1,400	1,400	2,800	175.0
Sone	Sone, Shozo	1915	ND	36	0	36	78-130	NA	6,925	130	7,055	195.9
Terusato	Fujii Kogyo KK	1922	ND	6	0	6	100-200	NA	NA	1,891	1,891	315.1

NA: Not applicable ND: No data available SOURCE: Individual mine owners

TABLE 11.- COSTS OF CLAY PRODUCTION BY MINES IN TOKIGUCHI DISTRICT a/

Mine	Present Owner	Year Mining Began	Average Overburden Thickness (meters)	Employees, March 1948			Wages (yen per day)		Production, 1947			Average Production Per Employee, 1947 (metric tons)
				Men	Women	Total	Men	Women	Gaerone	Kibushi	Total	
Fukasawa	Kato, Isumi	1937	3	14	1	15	110	70	2,697	NA	2,697	179.8
Godo	Tsuchimoto, Eikichi	1913	5	20	1	21	100	60	3,100	NA	3,100	147.6
Higashi-Jimon	Torazawa, Kozo	1934	5	7	1	8	120	60	1,088	NA	1,088	136.0
Hinoda (Marusu)	Kato, Masayuki	1935	ND	19	1	20	100-180	110	NA	968	968	48.4
Idobora	Kaniji, Mitsuo	1945	3	ND	ND	ND	ND	ND	809	1,517	2,326	ND
Jimon	Demoto, Katsuhei	1913	4	47	10	57	80	65	7,499	NA	7,499	131.6
Nendozaka	Sato, Tamakichi	1945	2	5	0	5	114	NA	NA	3,611	3,611	722.2
Nishiyama	Watanabe, Shigeru	1913	7	69	19	88	100	80	10,486	NA	10,486	119.1
Nishi-Fukasawa	Kato, Kokyu	1933	3	14	2	16	110	80	2,006	NA	2,006	125.3
Nitto-Kosai	Suzuki, Kantaro	1942	9	10	3	13	80	60	NA	1,239	1,239	95.3
Okumura	Okumura, Yoshizo	1909	30	58	0	58	130-170	NA	12,045	5,526	17,571	302.9
Okuyama	Kyoritsu Genryo KK	1909	ND	ND	ND	ND	ND	ND	6,800	5,300	12,100	ND
Sawabora	Tsuchimoto, Hanjiro	1940	5	31	3	34	140	80	485	NA	485	28.9
Shimmeiyama	Tsuchiya, Kihachi	1937	2	17	4	21	110	80	NA	2,480	2,480	118.1
Tuwa	Tsuchimoto, Tatsuzo	1945	5	13	2	15	110	70	1,087	NA	1,087	72.4
Tokiguchi	Okumoto, Genichi	1945	3	14	3	17	100	80	NA	1,196	1,196	70.3
Toridayama	Torazawa, Ryoichi	1934	6	19	1	20	110	80	1,375	597	1,972	98.6
Urayama	Tsuchimoto, Matsuo	1945	3	17	0	17	72	NA	2,360	NA	2,360	138.8
Watanabe	Watanabe, Shigeru	1941	3	19	0	19	80	NA	NA	1,546	1,546	81.3
Yamaka (Wake)	Kato, Shoroku	1928	2	4	5	9	ND	ND	2,117	NA	2,117	235.2

a/ Production costs for March 1948 are given as an average for all mines of the district, as follows (yen per ton): materials, 156; labor, 273; office expense, 30; total, 459.

NA: Not applicable ND: No data available SOURCE: Individual mine owners

TABLE 12.- COSTS OF CLAY PRODUCTION BY MINES IN TAJIMI DISTRICT

Mine	Present Owner	Year Mining Began	Production Costs, March 1948 (yen per ton)				Employees, March 1948			Wages (yen per day)		Production, 1947			Average Production Per Employee, 1947 (metric tons)
			Overburden Stripping	Other Mining Costs		Total	Men	Women	Total	Men	Women	Gaerone	Kibushi	Total	
				Direct	Indirect										
Asaoka	Asaoka, Seiichi	1943	ND	120	65	185	ND	ND	ND	ND	ND	NA	1,345	1,345	ND
Etsubora	Inagaki, Kintaro	1916	60	80	47	187	21	0	21	100-140	NA	NA	3,649	3,649	173.7
Fukenji	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	617	617	ND
Ikuta	Shibata, Shigeru	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	4,115	4,115	ND
Inahoshiba (Marusan)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	0	0	ND
Kasahara	Nichchu Kogyo KK	1938	ND	150	105	255	13	1	14	150-180	ND	2,797	0	2,797	199.8
Marusetsu	Inagaki Kogyo KK	1939	ND	ND	ND	ND	ND	ND	18	ND	ND	NA	3,000	3,000	166.6
Maruha	Saito, Takeshi	1913	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	1,200	1,200	ND
Misuno	Misuno, Noboru	1935	ND	ND	ND	ND	6	0	6	230	NA	NA	1,200	1,200	200.0
Ohata Gedo	Misuno, Ryoichi	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	0	0	ND
Onada	Onada KK	1943	ND	ND	ND	ND	ND	ND	8	ND	ND	NA	2,300	2,300	287.5
Onada Asaoka	Asaoka, Seiichi	1942	ND	ND	ND	ND	15	0	15	160	NA	NA	2,065	2,065	137.7
Ushigome	Tokyo Togyo KK	1930	ND	185	48	233	21	0	21	450-180	NA	NA	16 599	16,599	790.8
Yamamoto	Kato, Matsaichiro	1946	ND	ND	ND	ND	ND	ND	38	ND	ND	NA	9,000	9,000	236.9

NA: Not applicable ND: No data available SOURCE: Mine owners

TABLE 13 - COSTS OF CLAY PRODUCTION BY MINES IN MIE AND NARA PREFECTURES

Mine	Present Owner	Year Mining Began	Average Overburden Thickness (meters)	Production Costs, March 1948 (yen per ton)				Employees, March 1948			Wages (yen per day)		Production, 1947			Average Production Per Employee, 1947 (metric tons)
				Overburden Stripping	Other Mining Costs		Total	Men	Women	Total	Men	Women	Gaerone	Kibushi	Total	
					Direct	Indirect										
Daido	Matsumoto, Toshino	1948	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	0	0	ND
Hanagaki	Fukui Shoko KK	1943	ND	ND	205	153	358	15	1	16	80-150	40	NA	1,830	1,830	114.4
Hirosawa	Sana Taikarenga KK	1937	6	60	120	160	340	2	2	4	120	80	40	462	502	125.5
Ishikawa	Kasagi Kogyo KK	1947	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	421	421	ND
Ishiuchi	Aho, Haruo	1935	3	ND	ND	ND	ND	8	0	8	ND	NA	NA	810	810	101.2
Kaneteubo	Fukumori, T.	1948	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	0	0	ND
Kansai	Kansai Togyo Genryo KK	1931	ND	ND	ND	ND	ND	4	0	4	100	NA	NA	ND	ND	ND
Katsura	Mie Kogyo KK	1939	3	ND	ND	ND	ND	8	2	10	30-50	15-20	NA	294	294	73.5
Kawai (Nabari)	Kawai, Saheiji	1938	1	ND	15	20	45	8	2	10	90-125	NA	NA	1,680	1,680	168.0
Kinki Bozai	Kinki Bozai KK	1925	1	ND	ND	ND	ND	11	0	11	ND	ND	NA	2,300	2,300	209.0
Kinto	Mori, Kunihito	1943	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	0	0	ND
Kitayama	Kitayama, Takeshi	1910	ND	ND	ND	ND	400	13	1	14	50-150	50-70	1,901	1,688	3,589	256.4
Kozarashi	Kozarashi, Jisaku	1937	3	ND	130	100	230	3	0	3	80-100	NA	NA	850	850	283.3
Minami	Minami, Kumezo	1926	ND	ND	ND	ND	ND	3	0	3	150-200	NA	70	160	230	76.6
Mukaidani	Takashima, Matajiro	1945	12	42	55	63	160	14	0	14	80-130	NA	NA	1,978	1,978	141.3
Niwajiri	Kawaguchi, Chuzo	1932	ND	ND	80	170	250	4	1	5	80-150	40-60	NA	411	411	82.2
Shidatani	Maruyama, Tokujiro	1920	30	ND	200	89	289	32	5	37	80-170	80-100	261	346	607	16.4
Shobuike	Kusakabe, Yoshio	1938	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND
Shorinbo	Shimagahara-mura	1940	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	0	0	ND
Suga	Suga, Kotaro	1920	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	174	174	ND
Sugiyama	Sugiyama, Seiji	1936	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	646	646	ND
Tonokawa	Machimaka, Seiichi	1945	ND	ND	ND	ND	ND	1	0	1	150	NA	NA	89	89	89.0
Tosa	Tosa, Tatsue	1948	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	0	0	ND
Ueda	Ueda, Masaya	1925	3	ND	70	70	140	5	0	5	50	NA	NA	470	470	94.0
Ueno	Ueno, Toshimatsu	1938	7-9	ND	215	119	334	ND	ND	ND	ND	ND	NA	0	0	ND
Uchikoshi	Takashima, Juko	1940	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	0	0	ND
Yamada	Yamada, Takenosuke	1943	4-5	ND	ND	ND	190	4	0	4	60-80	NA	NA	ND	ND	ND
Yamakawa	Yamakawa, Shikanosuke	1943	ND	ND	ND	ND	180	22	0	22	60-100	NA	NA	ND	ND	ND

NA: Not applicable ND: No data available SOURCE: Individual mine owners

TABLE 14.- PRODUCTION OF KIBUSHI BY MINES IN MIE AND NARA PREFECTURES, 1925-48 a/
(metric tons)

Mine	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	Total
Daido																								736	736
Hanagaki																			1,450	2,200	2,600	1,590	1,830	2,319	11,989
Hirosawa													810	965	1,220	1,130	910	925	1,305	1,427	178	335	462	1,670	11,337
Ishikawa																							421	55	476
Ishiuchi											ND	ND	ND	ND	ND	ND	ND	ND	600	1,700	125	675	810	747	4,657
Kanetsubo																								2,034	2,034
Kansai							ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	77	77
Katsura															ND	3,644	2,043	5,851	5,591	4,849	2,596	861	294	2,097	27,826
Kawai (Nabari)														3,600	3,000	3,200	3,650	3,000	3,300	4,000	3,600	3,800	1,680	459	33,289
Kinki Rosai	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1,720	1,240	2,300	247	5,507
Kinto																			300	1,000	950	1,151	0	437	3,838
Kitayama	7,289	6,136	5,054	5,044	4,857	3,356	2,394	6,519	6,220	2,667	1,733	5,433	4,231	3,235	2,402	6,456	3,293	2,665	5,221	4,352	1,722	633	1,688	4,247	96,847
Kusunoki													600	750	900	1,050	1,500	950	1,000	500	300	700	850	564	9,664
Minami		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	160	0	160
Muraidani																					92	2,166	1,978	2,997	6,592
Niwajiri								ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	30	235	310	340	552	411	97	1,975
Shidatani	1,500	1,500	1,500	1,500	1,500	2,160	2,400	2,400	3,000	3,000	3,600	4,200	4,800	4,800	4,800	4,200	2,700	2,400	2,400	3,000	1,200	670	446	282	59,858
Shobuike														ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	28
Shorinbo																500	2,100	3,260	3,500	2,600	2,100	406	0	55	14,521
Suga	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1,000	100	174	0	1,274
Sugiyama												ND	ND	ND	ND	ND	ND	ND	ND	ND	629	758	696	227	2,310
Tonokawa																					218	381	89	1,207	1,895
Tosa																								2,115	2,115
Ueda	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	470	1,222	1,692
Ueno														ND	ND	ND	ND	ND	ND	ND	ND	ND	0	1,350	1,350
Uchikoshi																900	3,600	3,600	3,600	3,600	3,600	3,600	0	500	23,000
Yamada																			1,108	872	295	ND	ND	1,018	3,293
Yamakawa																			ND	ND	ND	ND	ND	2,282	2,282
TOTAL	8,789	7,636	6,554	6,544	6,357	5,516	4,794	8,919	9,220	5,667	5,333	9,633	10,441	13,350	12,322	21,080	19,796	22,681	29,610	30,410	23,265	19,618	14,659	29,069	331,263

a/ Blanks indicate production had not yet begun.
ND: No data available
SOURCE: 1925-47, individual mine owners; 1948, Mining Bureau, Ministry of International Trade and Industry.

TABLE 15.- COSTS OF FIRE CLAY PRODUCTION BY MINES IN JOBAN AREA

Mine	Owner	Year Mining Began	Date	Employees			Total Production Cost (yen per ton at mine)
				Men	Women	Total	
Funao	Funao, Chojiro	1890	Mar 48	15	5	20	ND
Hichiyo Akai	Nippon Togyo KK	1934	Mar 48	14	8	22	260
Hisao Akai	Hisao Togyo KK	1938	Apr 48	11	6	17	260
Shinagawa Fukushima	Shinagawa Shirorenga KK	1929	NA	ND	ND	ND	ND
Shinagawa Akai	Shinagawa Shirorenga KK	1885	Mar 48	61	21	102	630
Shinagawa Hirono	Shinagawa Shirorenga KK	1932	May 47	53	21	74	280
Shinagawa Kido	Shinagawa Shirorenga KK	1943	NA	ND	ND	ND	ND

NA: Not applicable
ND: No data available
SOURCE: Individual mine owners

TABLE 16.- PRODUCTION OF FIRE CLAY BY MINES IN JOBAN AREA, 1925 - 48 a/
(METRIC TONS)

Mine	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	Total
Funao	ND	ND	ND	ND	1,200	4,780	3,600	4,000	5,400	3,800	5,100	3,200	4,500	5,500	5,000	5,400	6,000	7,500	6,500	10,110	3,800	2,000	6,100	50	93,940
Nichiyo Akai										ND	ND	ND	ND	3,027	3,135	1,700	1,100	1,981	1,400	1,423	592	1,679	1,669	885	18,591
Niseo Akai														ND	ND	ND	ND	ND	ND	ND	ND	52	397	427	876
Shinagawa Fukushima					ND	1,499	1,040	2,671	7,824	9,604	10,807	8,172	9,015	6,927	6,600	6,482	8,114	5,232	5,255	4,217	2,551	1,015	1,500	b/	98,725
Shinagawa Akai	8,500	9,500	10,000	10,348	15,037	22,121	23,142	17,774	4,374	11,526	14,433	18,070	2,543	14,638	17,064	16,775	12,822	18,992	17,477	17,151	2,861	1,510	1,813	8,016b/	295,587
Shinagawa Hirono								650	2,100	3,890	4,800	5,328	12,850	19,650	23,656	18,177	26,046	21,935	20,513	16,443	7,170	2,136	10,600	9,310	205,254
Shinagawa Kido																			348	1,816	1,137	291	1,500	3,500	8,592
TOTAL	8,500	9,500	10,000	10,348	16,237	28,400	27,782	25,295	19,698	28,820	35,140	34,770	28,908	49,742	55,455	48,534	54,082	54,740	51,493	51,160	18,111	8,683	23,579	22,186	721,165

a/ Blanks indicate production had not yet begun.
b/ Production from Shinagawa's Akai and Fukushima mines reported together.
ND: No data available
SOURCE: 1925-47, individual mine owners; 1948, Mining Bureau, Ministry of International Trade and Industry.

TABLE 17.- COSTS OF FIRE CLAY PRODUCTION BY IWATE MINE, AUGUST 1948

Item	Quantity or Number	Unit Price (yen)	Total Cost	Cost Per Ton a/
Materials				
Timbers	75.76 koku	362.63	27,473	24.96
Pipes, cable	144.4 kg	18.79	2,713	2.46
Explosives	739.8 kg	54.82	40,171	36.49
Electrical equipment	NA	NA	15,947	14.49
Tools, machine parts	NA	NA	988	0.90
Oil, gas	83.3 liters	16.17	1,347	1.22
Coal b/	37.10 MT	2,530.24	93,882	85.28
Miscellaneous		NA	22,463	20.40
Total			204,985	186.20
Wages				
Staff members	20	3,903.85	78,077	70.92
Underground workers	53	4,402.55	233,335	211.95
Surface workers	51	2,511.92	128,108	116.37
Family allowances	124	2,235.30	277,177	251.76
Wages advanced for terminated contracts	NA	NA	11,920	10.83
Insurance, income tax	NA	NA	40,960	37.11
Total			769,477	698.96
Miscellaneous				
Repairs by private contractors c/	NA	NA	142,166	129.14
Electric power	NA	NA	21,447	19.48
Traveling and correspondence	NA	NA	37,064	33.67
Fixed assets depreciation	NA	NA	18,630	16.92
Donations for schools, charities	NA	NA	76,408	69.41
Total			295,715	268.62
GRAND TOTAL			1,270,177	1,153.76

a/ Total production was 1,100.88 metric tons.
b/ For generating steam to operate hoist at loading platform
c/ During the fall flood season this expense is considerably higher.
NA: Not applicable
SOURCE: Mine officials

TABLE 18. - COSTS OF FIRE CLAY PRODUCTION IN IIZUKA AREA

Mine a/	Owner	Year Mining Began	Production Costs, February 1948 (yen per metric ton)					Employees, February 1948							Wages (yen per day)		Average Monthly Production, Jan-May 1948 (metric tons)	
								Laborers			Staff							
			Product	Mining and Burning	Office	Miscellaneous b/	Total	Men	Women	Total	Men	Women	Total	Total	Men	Women	Total	Per Employee
Akaike	Iwamoto, Hisashi	1946	Raw clay	220	40	210	470	ND	ND	91	ND	ND	5	96	90-150	90-110	606	6.3
			Burned clay	ND	ND	ND	ND											
Futase	Nitteteu Kogyo KK	1944	Raw clay	185	25	120	330	ND	ND	ND	ND	ND	ND	33	ND	ND	139	4.2
Harada	Harada, Masutaro	1937	Raw clay	NA	NA	NA	NA	ND	ND	ND	ND	ND	ND	11	ND	ND	0	0.0
Iizuka	Nishitaki, Tsunekichi	1940	Raw clay	ND	ND	ND	250	ND	ND	ND	ND	ND	ND	12	50-60	40-50	27	2.3
			Burned clay	ND	ND	ND												
Keisen	Sano, Gihei	1945	Raw clay	NA	NA	NA	NA	ND	ND	ND	ND	ND	ND	14	ND	ND	0	0.0
Matsuo	Matsuo, Kumakichi	1937	Raw clay	168	83	257	508	7	24	31	3	0	3	34	60	50	107	3.2
Sano	Sano, Gihei	1939	Raw clay	200	70	50	320	4	26	30	2	0	2	32	60-90	47-55	230	7.2
Taniguchi	Taniguchi, Sakae	1944	Raw clay	60	30	0	90	4	2	6	ND	ND	ND	6	50-100	40-45	26	4.3
Torada Shakanoo	Torada, Masajiro	1945)	Raw clay	150	50	70	270	11	16	27	1	0	1	28	57-76	50-65	279	10.0
Torada Ito	Torada, Masajiro	1942)	Burned clay	350	50	70	470											
Tsubone	Tsubone, Yoshitoshi	1937	Raw clay	230	30	40	300	11	14	25	ND	ND	ND	25	50-60	40-50	271	10.8
Yamakura Oita	Yamakura, Tomoroku	1944)	Raw clay	150	70	50	270	19	27	46	5	1	6	52	37-76	37-52	272	5.2
Yamakura Shakanoo	Yamakura, Tomoroku	1944)	Burned clay	350	70	50	470											
Yamakura Iizuka	Yamakura, Tomoroku	1930)																

a/ In addition to the mines listed herein, the Fujii, Ikejiri, Ito, Itoda, Iwaibara, Takabo, and Torada Shakanoo mines opened during 1948. Costs and ownership data are not available.
b/ Includes taxes, depreciation, welfare, and transportation on the mine properties.
NA: Not applicable
ND: No data available
SOURCE: Individual mine records

TABLE 19. - PRODUCTION OF FIRE CLAY IN IIZUKA AREA, 1937-48 a/
(metric tons)

Mine	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	Total
Akaike										825	7,453	1,994	10,272
Fujii												7,335	7,335
Futase								224	306	571	408	1,255	2,764
Harada	1,500	2,500	3,000	2,500	2,000	2,500	2,000	1,500	1,180	2,500	2,000	0	21,180
Iizuka				ND	ND	ND	ND	ND	348	306	146	105	905
Ikejiri												401	401
Ito												1,809	1,809
Itoda												383	383
Iwaibara												2,846	2,846
Keisen									900	1,200	ND	0	2,100
Matsuo	ND	8,082	5,649	6,489	4,233	3,128	2,290	3,669	2,641	1,217	1,980	1,858	41,746
Sano	ND	ND	900	1,200	1,550	2,000	2,000	2,400	3,300	2,000	1,750	3,123	20,223
Takabo												90	90
Taniguchi								125	547	0	385	259	1,316
Torada Kamiyamada												120	120
Torada Shakanoo									135	760	402	1,469	3,266
Torada Ito						2,050	2,341	1,734	852	561	1,945		9,483
Tsubone	800	1,500	3,000	2,400	2,400	2,800	3,000	3,000	1,800	2,000	3,750	4,268	30,718
Yamakura Iizuka	ND	4,851	3,861	3,012	4,324	3,416	4,801	2,413	1,549	1,487	1,264	1,797	32,775
Yamakura Oita								530	530	344	290	407	2,071
Yamakura Shakanoo								145	446	733	641	886	3,054
TOTAL	2,300	16,933	16,410	16,101	14,507	15,894	16,432	16,743	14,534	14,456	22,614	30,915	196,787

a/ Blanks indicate production had not yet begun.
ND: No data available
SOURCE: 1937-47, individual mine owners; 1948, Mining Bureau, Ministry of International Trade and Industry.

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