

GOVERNMENT OF RAJASTHAN
DEPARTMENT OF MINES & GEOLOGY



सत्यमेव जयते

CLAYS OF RAJASTHAN



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PREFACE

Rajasthan has been fortunate to possess fairly good quality and quantity of clays. The information here has been provided from various reports prepared by the Department on the basis of mineral surveys and prospecting, analyses in the Departmental Chemical Laboratory and on the basis of work done on representative samples sent to Central Glass and Ceramic Research Institute, Jadavpur, Calcutta.

The undersigned acknowledges the assistance rendered by Shri P.D. Swami, Chemist-cum-Ceramic Technologist of the Department, in collecting and preparing this report.

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CONTENTS.

	<i>Page</i>
1. Introduction	1
2. Description of clay deposits	1—19
(a) Ajmer division	2
(b) Bikaner division	5
(c) Jodhpur division	9
(d) Udaipur division	14
(e) Kotah division	18
3. Utilisation of clays in Rajasthan	19
4. Conclusion	20
APPENDIX I—A list of lease holders in clays and other Ceramic minerals	21
APPENDIX. II—A statement giving production of Ceramic minerals	30

Map of Rajasthan showing occurrences of clay deposits.

CLAYS OF RAJASTHAN

Introduction:—

By the word clay is understood a natural, earthy, fine grained material which becomes plastic when mixed with limited amount of water. Plasticity is the property of the moistened material which could be deformed by the application of pressure; the deformed shape being retained when pressure is removed. Chemically clay is a hydrated silicate of alumina and contains usually silica, alumina and water but frequently also some quantity of iron, alkalis and alkaline earths. Some clays possess very little plasticity. They are called flint clays. Clays are mainly classified into china clays, ball clays, fire clays and flint clays. According to formation, clays are divided into primary clays and secondary clays. Primary clays are residual clays which are formed by decomposition of rock masses, the product remains where the rock is decomposed. China clays are residual clays which burn white. In chemical composition they are hydrated aluminium silicate and contain 39.5% Al_2O_3 , 14% water and 46.5% SiO_2 . Pure china clay or kaolin of commerce contains about .05% Fe_2O_3 and 0.1-2.5% KNaO and CaMgO . Secondary clays are those clays which have been removed from their place of origin. These are also called sedimentary clays. Ball clays, fire clays and flint clays are sedimentary clays. Ball clays contain organic matter and are highly plastic. Their colour may be dark brown, black, light brown, grey or pink as mined but they fire to white or nearly white. Fire clays are coal measure clays of low flux content while the flint clays occur as non-plastic strata or pockets in beds of plastic coal measure clays. They look like flint rock but are slightly softer. They are practically devoid of plasticity even in powdered state.

A few clays of Rajasthan are china clays mostly in Ajmer and Udaipur divisions, while those found in Bikaner and Jodhpur divisions are either ball clays or plastic fire clays. An attempt is made in the following pages to describe these clays.

Description of clay deposits:—

Rajasthan is richly endowed with various types of clays. These are found almost in every division of the State, particularly in Ajmer, Bikaner and Jodhpur divisions.

Ajmer Division :—

(1) Basu (76°36' : 26°6')— In Sawai Madhopur district about 8 miles from Malarna railway station there is a clay deposit located in more or less a horse shaped nallah about 400 yards south of Basu village. It is a primary china clay and is white in colour. It is parctically free from grit. The thickness of the bed is 6'-9' and the lateral extent is 450×45 sq. yds. The reserve of this clay is estimated to be about 75,000 tons. Its chemical composition is given below:—

Al ₂ O ₃	38.54%
SiO ₂	46.28%
Fe ₂ O ₃	0.13%
Ti ₂ O	1.58%
CaO	0.18%
KNaO	0.46% and
Loss on ignition	12.18%.

(2) Raesena (76°36' : 26°41')— In Sawai Madhopur district about 18 miles from Gangapur railway station there is a clay occurrence near village Raesena on a hillock. It is connected partly by metalled and partly by fair weather road. The clay is residual china clay and is formed by kaolinisation of felspathic rock. It is white in colour and possesses good plasticity. A sample of this clay was tested at the Central Glass and Ceramic Research Institute, Calcutta. It burns to white colour and is found suitable for ceramic manufacture. It analyses to :—

SiO ₂	40.28%
Al ₂ O ₃	34.44%
Fe ₂ O ₃	0.30%
TiO ₂	1.66%
CaO	0.25%
MgO	0.36%
KNaO	0.14%

and there is 12.37% loss on ignition.

Total clay content is 90.30%. The reserve of this clay deposit has not been estimated.

(3) Phalodi (76°20' : 25°51')—The clay deposit is located at 2 miles from Phalodi village in Sawai Madhopur district. It

is towards south of Rawajna Dungar railway station. It runs along the southern slope of a hillock. Extent of the deposit is roughly 500' × 150' × 12' and there is an overburden of 25' thick shaly quartzite. It is a residual primary clay. Its chemical analysis is given below:—

SiO ₂	64.48%
Al ₂ O ₃	16.49%
Fe ₂ O	5.36%
TiO ₂	1.16%
CaO	0.10%
MgO	2.55%
KNaO	6.16%
Loss on ignition	4.70%

Its available reserve is about 38,000 tons.

(4) Buchara (75°59':27°33')—The clay occurrence is about a furlong east of the village Buchara in Sikar district along the dip slope of the hills at an elevation of about 120' from the village level. It is formed by the kaolinisation of potash feldspar and is mixed with quartz and mica flakes. The quality can be improved by washing. Clay is a primary type of china clay and is white in colour. It is fairly plastic and suitable for use in the manufacture of pottery ware. It analyses to:—

SiO ₂	47.48%
Al ₂ O ₃	36.14%
Fe ₂ O ₃	0.55%
TiO ₂	Trace.
CaO	2.1%

and there is 14.18% loss on ignition.

It is a small deposit and the reserves are estimated in the neighbourhood of 20,000 tons.

(5) Torda (76°3':27°35')—This clay deposit is also in Sikar district. It occurs at about 3 miles east of Buchara clay deposit and about 4 miles west of Paota in granite pegmatites in their contact zone with quartzites. The clay is a residual clay and white in colour. Its extent is 200' × 70' × 60'. The deposit may yield about 10,000 tons of clay after washing. Chemical analysis of clay is as under:—

SiO ₂	45.86%
Al ₂ O ₃	37.42%

TiO ₂	0.12%
CaO	1.12%
MgO	0.15%
KNaO	0.25%
Loss on ignition	13.66%

(6) Purushottampura (76°5' 30" : 27°42' 30")—The clay deposit is located about one mile north west of the village which is about 15 miles north of Buchara and about 10 miles NNW of Paota in Sikar district. Clay is a residual clay and is formed by kaolinisation of granite pegmatites. It is white in colour and possesses fair degree of plasticity.

It contains :—

SiO ₂	52.56%
Al ₂ O ₃	34.1%
FeO	0.32%
TiO ₂	0.62%
Ca	1.72%

and there is 10.7% loss on ignition.

It is a small deposit and is not likely to yield more than a few thousand tons of clay.

(7) Ghasko-ki-Dhani (76°5' 30" : 27°28')—The place is about 47 miles north of Jaipur on Jaipur-Paota road and the clay deposit is just west of the village Ghasko-ki-Dhani also known as Babhru-ki-Dhani. The clay is white in colour but at places becomes pinkish due to presence of iron as impurity. Its lateral extent is 360 × 35 sq. yds. It is a small deposit and clay is consumed locally.

(8) Baswa Gate (76°35' : 27°9')—The deposit is located about few furlongs from Rajgarh town in Alwar district in a hillock. The extent of the deposit is about 20' × 10' × 30'. There is a 10-25' overburden of alluvium and pebbles. It is a residual china clay and analyses to :—

SiO ₂	62.25%
Al ₂ O ₃	26.18%
Fe ₂ O ₃	1.10%
TiO ₂	1.02%

CaO	0.32%
KNaO	0.89%

and there is 8.15% loss on ignition.

It is a small occurrence.

Bikaner Division :—

In the Bikaner division clay bearing area mostly lies in the Magra Tehsil of Bikaner district. Some clay occurrences are also located around Bikaner city.

(1) Mudh (72°54' : 27°52')—In the Magra tehsil of Bikaner district there occurs an important large deposit of clay near the village Mudh which is about 3 miles from Shri Kolayatji railway station. The average thickness of the deposit is about 15' and it covers an area of about 17,00,000 sq. ft. Clay seems to be of secondary origin and may be termed as plastic fire clay. The reserves of this clay have been estimated to be in the neighbourhood of two million tons. The overlying rocks are calcareous and ferruginous sandstones and grit. The clay is greyish white to white in colour, soft and soapy to touch. It possesses good plasticity, the water of plasticity being 27.6%. Its chemical analysis is as given below :—

	1	2	3
SiO ₂	59.81%	42.71%	58.08%
Al ₂ O ₃	26.16%	35.40%	27.84%
Fe ₂ O ₃	1.10%	1.57%	0.80%
TiO ₂	2.91%	2.00%	..
CaO	Trace	Trace	1.21%
MgO	Trace	0.28%	..
K ₂ O	0.98%	0.07%	Trace.
Na ₂ O	0.51%		
Loss on ignition	9.98%	12.78%	11.54%

Its rational analysis as calculated from chemical analysis of sample number 1 is as follows :—

Clay substance	61.2%
Felspathic matter	10.0%
Quartz	24.4%
Other constituents	4.4%

Mineralogically the clay is mostly kaolinite. It has a dry linear shrinkage of 6.6% and dry transverse strength of 528 p. s.i. It has a p.c.e. value of Orton cone 30-31 i.e. 1650°-1680° C. When fired the colour of the clay becomes pale pinkish white to cream to grey at higher temperatures. It develops some cracks. The fired shrinkage of the clay is 7.8% at Orton cone 14. It has 1.6% water absorption and 3.8% apparent porosity.

The clay was tested at the Central Glass and Ceramic Research Institute, Jadavpur and was found suitable for the manufacture of cream earthen ware, electric porcelain, high grade stone ware, vitrified dinner ware and moderate heat duty fire clay refractories. Test specimen made out of soft porcelain body containing this clay and fired to cone 10, i.e., 1305°C showed complete vitrification, its puncture voltage was 250.8 volts/mil.

(2) Chandi (73°0' : 27°53')—Another good deposit of clay is located about a mile north of village Chandi, about 5 miles from Shri Kolayatji railway station. The probable lateral extent of the deposit is about $\frac{1}{2}$ sq. mile and the thickness of the clay bed varies from of a couple of feet to above 25'. Clay is soft, greyish white in colour and possesses high degree of plasticity, the water of plasticity being 27.6%. In origin it is similar to Mudh clay. Its reserve is estimated to be 3 million Tons. The chemical analysis of this clay is as under :—

	By C.G.C.R.I.	By R. V. Briggs
SiO ₂	56.33%	45.15%
Al ₂ O ₃	29.37%	37.06%
Fe ₂ O ₃	0.99%	1.42%
TiO ₂	2.39%	2.56%
CaO	0.15%	0.11%
MgO	Trace.	0.31%
K ₂ O	0.76%	0.96%
Na ₂ O	0.44%	0.10%
Loss on ignition	9.90%	12.33%
		<hr/>
		100.00

It contains as per analysis 1, 70.3% clay substance 8.2% felspathic matter, 18.0% quartz and 3.5% other constituents. Mineralogically this clay is mostly kaolinite. It has a p.c.e. value of Orton cone 30-31, i.e., 1650-1680°C. It has a dry linear shrinkage of 5.8%, fired shrinkage of 8.8% at Orton cone 14 and 0.7% water absorption, when fired colour of the clay becomes pale pinkish white to cream to bluish grey at higher temperatures. The clay was tested at the Central Glass & Ceramic Research Institute, Jadavpur and was found suitable for the manufacture of:—

- (a) Cream earthen ware.
- (b) Electrical porcelain.
- (c) High grade stone ware.
- (d) Vitrified dinner ware, where white colour is not of prime importance, and
- (e) Moderate heat duty fire clay refractories.

(3) Kotri (72°55':27°50')—The deposit is located near Kotri, about 5 miles from Shri Kolayatji railway station. The clay bed is overlain by kankar, ferruginous sandstone, hematitic nodules and sand. The thickness of the bed is 10'. It is not a very large occurrence. The colour of the clay is greyish white to white. It analyses to:—

SiO ₂	56.90%
Al ₂ O ₃	24.17%
Fe ₂ O ₃	2.50%
TiO ₂	0.90%
CaO	2.40%
MgO	0.90%
KN ₂ O	2.90% and
Loss on ignition	9.60%.

The clay is similar in properties to Mudh clay.

(4) Navagaon (72°24':27°27').—The clay deposit is located 1 mile south of village Tareri on Kolayat-Bap road,

16 miles from Shri Kolayatji rail head. The thickness of clay bed is 60' and there is an overburden of about 100'. The clay is greyish white in colour, soapy to touch and moderately plastic; its water of plasticity being 20.62%. It is highly siliceous clay. It contains 58.36% silica, 27.60% alumina, 1.06% ferric oxide, 3.10% TiO_2 , 0.44% CaO , 0.12% MgO , 0.46% $KNaO$ and there was 8.86% loss on ignition. The reserve has not been estimated but the deposit is very large.

(5) Nal (73°-10' : 28°-00')—The clay occurs about a furlong from the Nal village which is 10 miles from Bikaner. It is a small occurrence and is consumed locally.

(6) Bikaner (73°-19' : 28°0')—The clay occurrence is near Shitla gate on the northern bank of Darjiyonki-Talai. It is greyish white in colour and moderately plastic, its water of plasticity being 15.33% only. Its chemical analysis is as under :—

SiO_2	66.34%
Fe_2O_3	0.17%
Al_2O_3	22.91%
TiO_2	1.86%
CaO	0.64%
MgO	0.11%

Loss on ignition 8.20%

A more siliceous clay also occurs at near Panchmukha Hanumanji. It is consumed locally.

(7) Dhaban (74°-30' : 29°-50')—In Ganganagar district there is a small clay deposit. It is greyish white in colour. The alumina content is 20.49% and SiO_2 51.02%.

(8) Palana (73°2 18' : 27° 51')—Palana is a railway station on Bikaner-Merta Road Section of Northern Railway and is situated 14 miles south of Bikaner city. The clay band occurs under the lignite seam and is therefore, termed as 'under clay'. It occurs at a depth of 210' to 250'. The clay is greyish white in colour and is refractory in nature. It is plastic fire clay.

Its p.c.e. value is Orton cone 31, i.e., 1680°C. The available reserves are roughly estimated to be 1.5 million tons. Its chemical analysis is given below :—

SiO ₂	59.24%
Al ₂ O ₃	23.40%
Fe ₂ O ₃	1.25%
TiO	1.83%
CaO	0.34%
MgO	0.30%
Na ₂ O	0.4%
K ₂ O	0.98%
Loss on ignition	12.28%

Its water of plasticity is 23.97%.

Jodhpur Division.

Clay occurs mostly in Nagaur, Pali, Jodhpur and Barmer districts in this division.

(1) Botia (71° 22' : 25° 59')— A fairly big deposit of clay is located at about 1½ miles South-west of Botia, which is 18 miles from Barmer railway station. It is soft and gritty and is greyish white to white in colour. Average thickness of clay bed is about 8'. It is fairly plastic clay, its water of plasticity being 25.1% on dry basis. It has dry linear shrinkage of 5.6% and fired linear shrinkage of 5% at Orton cone 14. Its dry transverse strength is 469 p.s.i. and fired transverse strength at cone 14 is 4105 p.s.i.. When fired its colour becomes pale white to cream at higher temperatures.

Its chemical analysis is given below :—

SiO ₂	59.68%
Al ₂ O ₃	25.66%

Fe ₂ O ₃	1.17%
TiO ₂	3.05%
CaO	0.27%
MgO	Trace
K ₂ O	0.13%
Na ₂ O	0.23%
Loss on ignition	9.98%

It contains 63.5% of clay substance, 2.7% felspathic matter, 28.1% quartz and 5.7% other constituents. It is mineralogically mostly kaolinite. Its p.c.e. value is Orton cone 31, i.e., 1680°C. Its specific gravity is 2.62%.

The clay was tested at the Central Glass & Ceramic Research Institute, Jadavpur and was found suitable for the manufacture of—

- (a) Cream earthenware,
- (b) Electrical porcelain,
- (c) High grade stoneware,
- (d) Vitrified ceramic ware where fired colour is not of prime importance, and
- (e) Moderate heat duty fire clay refractories.

The available reserves of this clay are about 1 million tons.

(2) Literiya (73°55':26°20').—The clay deposit is located at Literiya which is a small village in Jaitaran Tehsil of Pali District. It is 17 miles from Bilara railway station and 24 miles from Merta Road railway station. Clay occurs here near the top of Vindhyan limestone and is overlain by pebble beds. The clay bed dips at 12' to ENE. Recently the Department of Mines & Geology carried out prospecting operations and nine pits were dug to a depth of about 20'. The depth of the bed varies from 2' to 22'. The clay is greyish white in colour and at places it is iron stained. The clay is fairly plastic, the water of plasticity being 21.85%. Its chemical analysis is as under:—

SiO ₂	53.61%
Al ₂ O ₃	31.69%

Fe ₂ O ₃	0.05%
TiO ₂	3.10%
CaO	0.28%
MgO	0.11%
Loss on ignition	11.52%

The available reserve is estimated at 2,60,000 tons.

(3) Mundwa (73° 52' : 27° 8')—The clay occurrence is close to village Mundwa which is about 4 miles from the railway station of the same name in Nagaur district. The clay is greyish in colour. It vitrifies at 1300°C to a greyish mass. It analyses to:

SiO ₂	45.23%
Al ₂ O ₃	25.45%
Fe ₂ O ₃	10.24%
CaO	1.00%
MgO	Nil.
KNaO	6.3%

and there was 12.22% loss on ignition.

As the clay contains high percentage of iron oxide it obviously cannot be used as such for the manufacture of white ware.

(4) Khajwana (73°52'30" : 26°54'30")—This clay deposit is located at Khajwana in Nagaur district. The deposit is 4'-5'' thick occurring about a furlong west of Khajwana railway station. It is interbedded in Vindhyan sandstone. The deposit is fairly large. The clay is pinkish in colour. It shows no vitrification at 1320°C and develops a greyish tinge. Its chemical analysis is given below:—

SiO ₂	63.41%
Al ₂ O ₃	22.12%
Fe ₂ O ₃	1.42%
TiO ₂	0.24%
CaO	2.48%

MgO	0.76%
KNaO	2.11%
Loss on ignition	7.46%

The clay is not very plastic, its water of plasticity being only 16.12%.

(5) Saradhana ($73^{\circ} 32'30'' : 26^{\circ} 48'$)—The clay occurrence is near the village Saradhana in Nagaur district. It occurs as a bed of 8' thickness in Vindhyan sandstone. On analysis it gave:—

SiO ₂	65.24%
Al ₂ O ₃	18.52%
Fe ₂ O ₃	2.23%
TiO ₂	0.48%
CaO	2.16%
MgO	0.16%
KNaO	2.43%

and there was 8.08% loss on ignition.

It is a fairly plastic clay, the water of plasticity being 26.58%. The reserve has not been estimated.

(6) Indawar ($73^{\circ} 58'30'' : 26^{\circ} 34'$)—The clay at Indawar in Nagaur district occurs as a bed about 10' thick. The overburden consists of 10'-12' of kankar and 8'-10' of alluvium. The deposit is located at about 8 miles from Merta city railway station. The clay is fairly plastic and does not vitrify at 100°C.

It analyses to:—

SiO ₂	47.38%
Al ₂ O ₃	38.10%
Fe ₂ O ₃	0.79%
CaO	0.01%
MgO	0.52%
KNaO	0.5%

and Loss on ignition 13.81%

Another stray sample from this deposit on analysis gave 68.46% SiO_2 and only 16.91% Al_2O_3 . The reserves have not been estimated.

(7) Nimri ($73^\circ 58' : 26^\circ 5'$)—The clay deposit is in the vicinity of a large tank about a mile North of the village Nimri in Nagaur district which is about 8 miles from Khajwana railway station. It is greyish white to white in colour. It analyses to:—

SiO_2	51.50%
Al_2O_3	32.03%
Fe_2O_3	0.3%
CaO	1.51%
MgO	0.8%
KNaO	2.05%

and there is 11.54% loss on ignition.

(8) Gunga ($71^\circ 13' : 26^\circ 14'$)—About $\frac{1}{4}$ mile West of Gunga in Barmer district which is 34 miles from Uttarlai railway station and 36 miles from Barmer railway station there is a clay occurrence. It is greyish white in colour and is fairly plastic. Its chemical analysis is given below:—

	(1)	(2)
SiO_2	57.84%	57.11%
Al_2O_3	28.01%	34.20%
Fe_2O_3	3.19%	2.9%
TiO_2	0.12%	..
CaO	2.48%	..
MgO	1.74%	..
KNaO	0.54%	..
Loss on ignition	12.0%	11.87%

(9) Nimla ($71^\circ 20' : 26^\circ 03'$)—The deposit is $\frac{1}{2}$ mile south of the village Nimla which is 23 miles from the Barmer railway station. The clay occurs at a depth of 10'. It is a fine grained clay which is white in colour. The clay does not vitrify at 1400°C but its colour becomes yellowish. It is a fairly good clay and suitable for making medium grade ceramic wares.

(10) Bhadres (71°19':25°53')—Three miles east of Bhadres there is a clay deposit which is 3' thick and occurs under 5' of overburden. The deposit is 12 miles from Barmer railway station. Clay is greyish white but turns brown on firing. It contains:—

SiO ₂	55.37%
Al ₂ O ₃	28.18%
Fe ₂ O ₃	0.20%
CaO	1.33%
MgO	0.38%
TiO ₂	3.5%

and there is 10.80% loss on ignition.

(11) Rol (73° 50'30':26°43')—In Nagaur district at about 2 miles north of Jogi Magra railway station there is a clay occurrence 3'-4' thick in Vindhyan sandstone. It is pale white in colour with iron stains. The clay is fairly plastic and does not vitrify at 1350° C.

(12) Phalodi (72°-20':27°05')—There is a clay deposit near Phalodi in Jodhpur district. It is greyish white in colour and possesses good plasticity, its water of plasticity being 20.5% and dry linear shrinkage 4.9%.

On analysis it gave:—

SiO ₂	67.42%
Al ₂ O ₃	18.88%
Fe ₂ O ₃	2.22%
TiO ₂	1.24%
CaO	0.73%
MgO	1.2%
KNaO	2.69%

and there is loss on ignition 5.62%.

Udaipur division.—

The clay occurrences in Udaipur division are mostly located in Bhilwara and Chittorgarh districts.

(1) Mangrup (74° 40' : 25° 14')—The clay deposit is located near the village Mangrup in Bhilwara district at a distance of about 14 miles south of Bhilwara town. The nearest railway station is Hamirgarh. The clay occurs under an overburden of about 30'. The minimum thickness of the deposit is 3' to 4'. The reserve is estimated to the tune of 0.9 million tons. The clay is greyish white in colour and soapy to touch. Its specific gravity is 2.28. It is fairly soft and can easily be scratched with finger nail. Its chemical analysis is as follows :—

Free silica	3.37%
Combined silica	43.80%
Alumina	33.63%
Iron oxide (Fe ₂ O ₃)	1.17%
TiO ₂	2.50%
CaO	0.12%
MgO	0.92%
K ₂ O	3.06
Na ₂ O	0.24
Loss on ignition	10.65%
	<hr/>
	100.00%
Grit	4.08

The clay was tested at the Ceramics Department of Banaras Hindu University. Yield of clay after washing was 96%. Washed clay is very plastic and fine grained. It has a dry linear shrinkage of 2.5% and dry tensile strength of 50 p.s.i. The filtered properties are as follows :—

	Firing temperatures.			
	1000°	1100°	1200°	1300°C
Colour.	White	Yellowish white	Light Yellow	Ugly grey.
Shrinkage.	5.0%	10.0%	12.5%	12.5%
Porosity.	35.4%	18.6%	16.38%	6.12%
Tensile strength	293p.s.i.	530p.s.i.	360p.s.i.	384p.s.i.
Modulus of rupture.	2780p.s.i.	3415p.s.i.

Clay is suitable for making earthen ware, low temperature stoneware, procelain and china ware. In combination with other primary clays it can with advantage be used for making high temperature earthen ware and vitreous porcelain and chinaware.

(2) Eral (74° 39': 24° 54')—About six miles south-east of Chittorgarh railway station a clay deposit is located near the village Eral. Clay is formed from the kaolinisation of felspathic limestone of Nimbaheda stage. The deposit is very close to the junction of Nimbaheda limestone and Suket shales and is covered with a layer of soil varying in thickness of 2' to 8'. Clay is greyish white to white in colour and although siliceous at places it is fairly plastic. Its water of plasticity is 26.6% and dry linear shrinkage 4.9%. When analysed it gave:—

Free silica,	27.88%
Combined silica.	30.47%
Al ₂ O ₃	27.79%
Fe ₂ O ₃	0.85
TiO ₂	0.48%
CaO	0.12%
MgO	0.30%
K ₂ O	1.7%
Na ₂ O	0.66% and

there is 9.75% loss on ignition. It contains 22.39% grit.

The reserve of this clay deposit is estimated at 6 million tons.

(3) Sawa (74° 35': 24° 45'30')—There is a clay deposit near Sawa in Chittorgarh district with an overburden of 30'. It is 12 miles from Chittorgarh railway station. The deposit is quite extensive. Clay is greyish white in colour and moderately plastic. Its chemical analysis is given below:—

SiO ₂	66.75%
Fe ₂ O ₃	1.31%

Al ₂ O ₃	23.59%
TiO ₂	0.96%
CaO	0.37%
KNaO	1.33%
Loss on ignition	5.66%

It has a dry linear shrinkage of 3.15%. The wares of this clay were made at the Govt. Pottery Centre, Mandasaur (M.P.). They were fired at 1250° C. Fired colour of the clay is buff. It has 7.81% water absorption and 20.17% porosity. The clay is suitable for the manufacture of medium grade ceramic ware, i.e., earthen ware and semi vitreous porcelain ware.

(4) Manpura (74° 40':24° 56')—This deposit is to the north-east of Chittorgarh railway station. The clay is greyish-white in colour. It is bit inferior to Eral clay. The clay analyses to:—

SiO ₂	61.96%
Al ₂ O ₃	22.24%
Fe ₂ O	0.15%
TiO	1.2%
CaO	5.2%

and there is 7.5% loss on ignition.

The deposit is fairly large,

(5) Bahadurpura (74° 25':25° 30').—The deposit is located at two miles SW of Bahadurpura village which is 40 miles NE of Bhilwara town. There is an overburden of 5'. The clay is greyish-white in colour. On analysis it gave:—

SiO ₂	44.40%
Al ₂ O ₃	40.91%
Fe ₂ O	0.39%
TiO ₂	Trace.
CaO	0.70
MgO	Trace.
KNaO	1.1%

Loss on ignition 12.46%.

(6) Bari Sadri (74° 28':24" 25').—This clay occurrence is near village Badi Sadri in Udaipur district. The clay is pale-white in colour and is moderately plastic. It has 4.34% dry linear shrinkage and 19.31% water of plasticity. It is a small deposit. The clay contains:—

SiO ₂	58.88%
Al ₂ O ₃	25.77%
Fe ₂ O ₃	1.91%
TiO ₂	0.96%
CaO	1.02%
KNaO	0.32% and

there is 11.14% loss on ignition.

It is a small occurrence.

Kotah Division.

(1) Luharpura (75° 51':25" 32').—In Bundi district near the village Luharpura there occurs a clay deposit with an overburden of 10'-15' thick of felspathic sandstone. The extent of the deposit is nearly 100 acres. The clay is siliceous and pale-white, reddish or even violet in colour. The available reserve is estimated to be nearly 10,000 tons. It is, therefore, a small occurrence. It is consumed locally. Clay is formed by the kaolinisation of felspathic sandstone.

(2) Khara Sirol (77° 08'+25" 09').—The nearest rail-head is Baran in Kotah district which is about 44 miles from the deposit. The area extends for nearly 300 acres of which 270 acres are covered by a deposit of fire clay and rest by china clay. The clay is fairly plastic, its water of plasticity being 27.49%. It has a dry linear shrinkage of 2.53%. The reserves are estimated to be 70,000 tons of china clay and 65,000 tons of fire clay. Its chemical analysis is as given below:—

	(1)	(2)
SiO ₂	42.75%	43.50%
Al ₂ O ₃	37.58%	37.50%
Fe ₂ O ₃	2.36%	4.56%

TiO ₂	1.86%	
CaO	0.51%	0.23%
MgO	0.41%	0.21%
KNaO	0.22%	
Loss on ignition	14.58%	13.58%

(3) Manak Chowk (75° 54' : 25° 33')—In Bundi district about 1 mile NNE of Manak Chowk village and about 20 miles ENE of Bundi there is a clay occurrence which extends to an area of 50-100 acres. The clay is highly siliceous. It contains:—

SiO ₂	74.85%
Al ₂ O ₃	13.0%
Fe ₂ O ₃	2.0%
TiO ₂	0.96%
CaO	2.56%
MgO	0.32%
KNaO	0.3% and

there is 5.89% loss on ignition.

*The available reserve is 10,000 tons. It is a small occurrence.

Utilisation of clays in Rajasthan.

Besides clays there are other ceramic raw materials extensively available in Rajasthan. They are quartz, feldspar, talc, barytes, kyanite, etc. Feldspar occurs at Dungarwara in Jaipur district, Dadia, Bander Senri and Gujarwara in Ajmer district, Tatarpur and Khairtal in Alwar district, Chaondiya, Pratapgarh, Dingor, Thandi Beri, Bartia khurd and Bera in Pali district, and in various mica and beryl mines in Udaipur, Dungarpur, Banswara and Bhilwara districts. Quartz like feldspar occurs as a main constituent of the pegmatites and as such it is obtained as a by product from all the mica, beryl and felspar mines in all over Rajasthan. Talc occurrences in Rajasthan are at Dagotha, Jharna, Geejgarh and Garimora in Jaipur district, Ghewaria and Chandpura in Bhilwara district, Lakhawali, Lohagarh and Devpura in Udaipur district and Jakol and Deval in Dungarpur district. Barytes is mainly found in Alwar and Bharatpur districts. The places

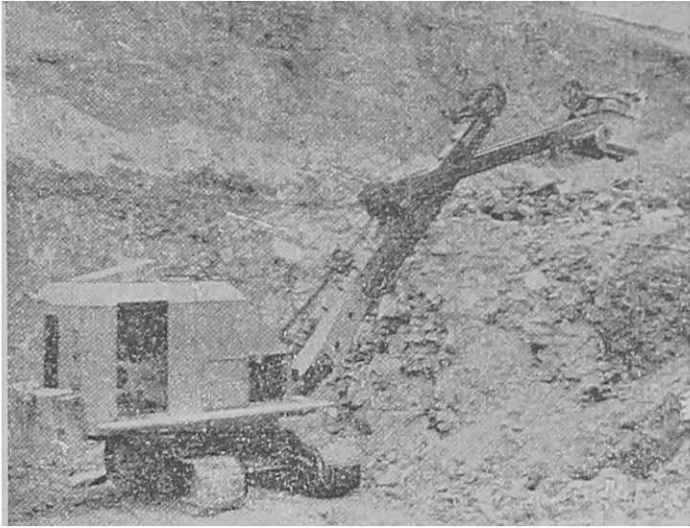
of its occurrences are Jamroli, Gwara, Khora, Makrera, Sainpuri, Bhurasidh, Bhakera, Umrain and Bhagat-ka-Bas in Alwar district and Hathori in Bharatpur district. Kyanite mineral occurs at Kishangarh in Ajmer District, Sansera, Vallabh-nagar and Mavli in Udaipur district and Dewal, Warlia, Saroda and Padri in Dungarpur district. A list of lease holders in clays and other ceramic minerals along with figures of production from Rajasthan mines and quarries is given in Appendix I and II.

These ceramic minerals could be used for the manufacture of such ceramic products as dinner ware, sanitary ware, sewer pipes, stone ware, refractory ware, electric porcelain and china. Thus there is fairly a good scope of a few ceramic plants being set up in Rajasthan. Location for such plants can be at Bharatpur, Alwar, Chittorgarh, Bikaner and Jaipur. Cheap electric power and necessary quantity of water and cheap unskilled labour in plenty could be available at all of these places. They are not very far off from the consuming centres also. Ceramic manufacturing plants should not be far away from the consuming centres as otherwise the finished ware are likely greatly to break during transit. Seen from this point of view the locations suggested are ideally suited.

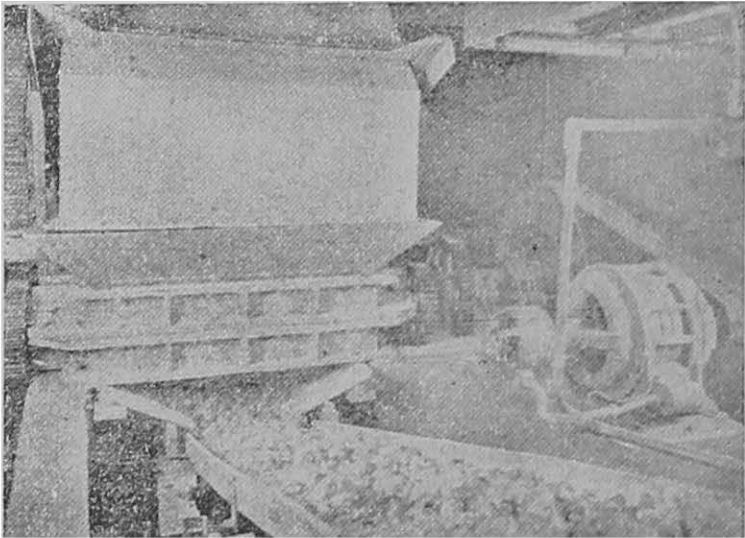
Conclusion.

It will thus be seen that the clay deposit at Buchara, Torda, Reesena and Basu in Ajmer division, Mudh, Chandi and Palana in Bikaner division, Botia, Literiya, Khajwana and Nimri in Jodhpur division and Eral, Mangrup, Bhadurpura and Sawa in Udaipur division and Khara Sirol in Kotah division seem promising. A few of them have been tested at the Central Glass and Ceramic Research Institute, Calcutta, and have been found suitable for manufacture of ceramic products like electric insulators, high grade stoneware, cream earthenware, vitreous porcelain and china ware and moderate heat duty refractory ware. There is ample quantity of both primary and secondary clays to feed a couple of ceramic plants manufacturing these items. As regards fuel, with the open cast mining of lignite at Palana, it would be available in plenty to meet the requirements of ceramic industry in the State.

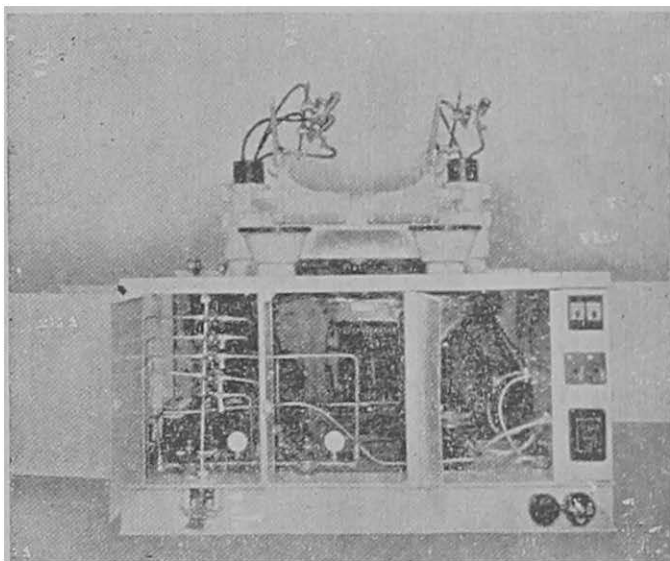
Thus Rajasthan today is in an excellent position to supply good quality clays to meet the needs of the ceramic plants in other parts of the country. Not only this, there is also a good scope for the establishment of at least one or two modern plants to undertake the manufacture of a variety of ceramic products.



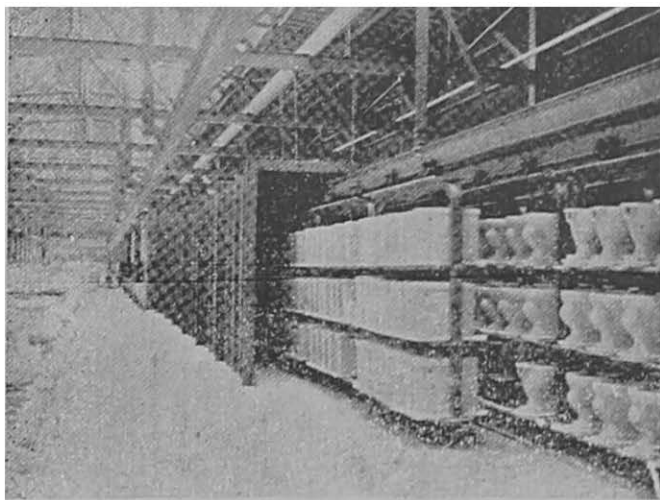
Clay winning



Crushing of clay in a double roll crusher



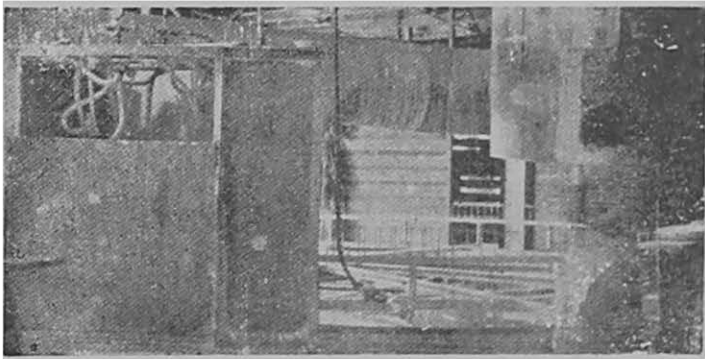
An automatic Jigging Machine



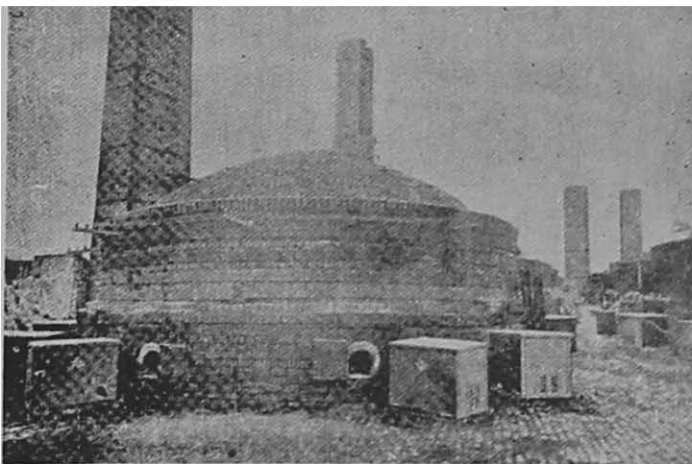
A continuous Drier for Sanitary ware



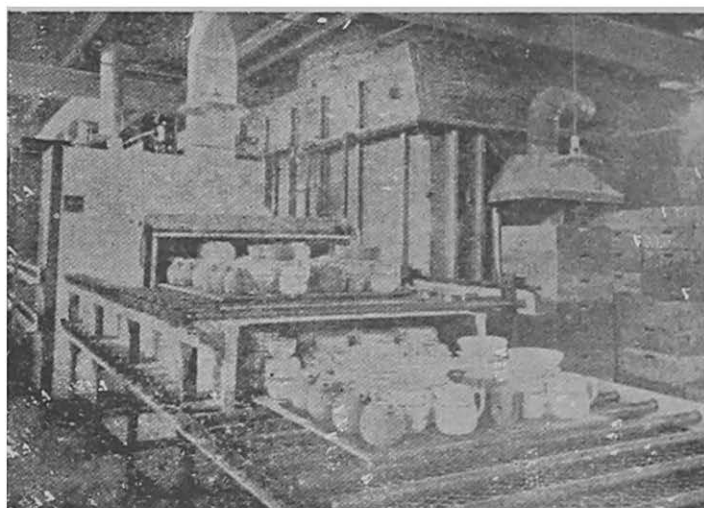
A Waste Heat Drier



A circular Glazing Machine



A round down draft Periodic Kiln



A Decorating Kiln



A Kiln car with Ceramic Ware

Appendix—I.

A list of lease holders in clays and other ceramic minerals.

(a) List of Leases & Licence Holders for Clays

S. N.	Name and address of the lessee.	Mineral.	Nature of Concession	Location.
1	2	3	4	5
1.	Shri Chand Behari Lal Mathur, New Colony, Jaipur	White clay.	Mining leases.	N. Toda.
2.	Shri Kishan Agarwal, Neeti Ka Thana.	-do-	-do-	N. Teluka Thand
3.	M/s Lilchand Khemrajmal, Jodhpur.	-do-	-do-	N. Bothia.
4.	M/s. Tajlaram & Sons K.E.M. Road, Bikaner.	-do-	-do-	N. Mudh.
5.	Shri Chand Behari Lal Mathur, New Colony, Jaipur.	China clay.	-do-	N. village Bhir.
6.	Shri Nandlal Agarwal Maonda.	White clay.	-do-	N. Lullogi.
7.	M/s. Indian Commercial Enterprises, Calcutta.	-do-	-do-	N. Kholi, Rasons.
8.	M/s. Makhan Lal Suri & Sons.	-do-	-do-	Chunchan.
9.	M/s. M. Khaju Lal & Co.	-do-	-do-	N. Basr.
10.	M/s. Bikaner Pottery Works Ltd., Bikaner.	China clay.	-do-	N. Mudh.
11.	M/s. Bhupal Works, Bhilwara.	Mining White clay.	-do-	N. Mangroop.
12.	Shri Hukam Singh Kachh-waha, Barmer.	Yellow Ochre.	-do-	N. Mandai.
13.	M/s. Aravali products, Bhilwara.	China clay.	prospecting Licence.	N. Eral & Seal-pura, (M.L. Under consideration).
14.	M/s. Mewar Trading Syndicate, Bhilwara.	-do-	-do-	N. Sindal (M.L. granted but agreement has not been executed)

1	2	3	4	5
15.	M/s. The General Produce Co., Jaipur.	China clay	Prospecting Licence	Danth.
16.	Shri Madholal Chowdhury Neem Ka Thana.	Fire Clay	-do-	Girori.
17.	Shri Sardar Ahmed Zaidi Sawai-Madhapur.	Yellow Ochra.	-do-	Bharatpur Balapura.
18.	Shri Kishan Agarwal Neem Ka Thana.	White clay.	-do-	Manoharpura.
19.	M/s. Shyam Investment Corporation, Strand Road Calcutta, 2.	-do-	-do-	N. Girdharpura.
20.	Shri Sohan Lal Joshi Jaipur.	Yellow Ochre, China clay.	-do-	N. Batu Ki Dhani.
21.	Shri Kedar Nath Vyas, Jaipur.	White Clay	-do-	Basklia.

(b) List of Leases and Licence Holders for Bentonite.

1.	M/s. Neel Kanth Chemical works, Balotra.	Bentonite.	Mining leases	Hathi-ki-Dhani.
2.	-do-	-do-	-do-	Akli.
3.	-do-	-do-	-do-	Bisala.
4.	M/s. Mahalaxmi Chemical work, Balotra.	-do-	-do-	Mandai.
5.	Shri Hukamsingh Kachh-waha, Jodhpur.	-do-	-do-	Thunbli.

(c) List of Lease and Licence Holders for Felspar.

1.	Shri J.K. Soniji, Ajmer.	Felspar.	Mining leases.	N. Ramsar.
2.	Shri J.K. Soniji, Ajmer.	-do-	-do-	N. Kalesra.
3.	Shri Ladoo Lal Kataria, Nasirabad.	-do-	-do-	N. Kalyanipura.
4.	Shri M/s. Aryan Industries, Ajmer.	-do-	-do-	N. Sorana.
5.	Shri Keshav Sen Kharwa, Ajmer.	-do-	-do-	N. Karwa.
6.	M/s. Gopilal Brij Raj, Beawar.	-do-	-do-	N. Rajgarh

1	2	3	4	5
7.	M/s. Mohanlal & Sons Nasirabad.	Felspar	Mining leases	N. Sanod.
8.	Shri Suganchand Mathur Beawar.	-do-	-do-	N. Surdia.
9.	Sm. Bhanwari Devi Nasirabad.	-do-	-do-	N. Kalan Khara.
10.	Shri F. C. Framji, Nasira- bad.	-do-	-do-	N. Sanod.
11.	M/s. Gopi Lal Brij Raj, Beawar.	-do-	-do-	N. Dhawli.
12.	Shri J. K. Soneji, Hathi Bhatta, Ajmer.	-do-	-do-	N. Nagolao.
13.	M/s. Bharat Mineral Supply Corporation, Ajmer.	-do-	-do-	N. Boraj.
14.	M/s. Chhittarmal Soni & Bros. Mahajhori, Ajmer.	-do-	-do-	N. Rajgarh.
15.	M/s. Mica Minerals Ltd., Ajmer.	-do-	-do-	N. Makrera.
16.	Shri Moolchand Siroya, Ajmer.	-do-	-do-	N. Rajgarh.
17.	M/s. Chand Mal & Co., Kishangurh.	-do-	-do-	N. Nareli.
18.	M/s. Sharda & Co., Nasira- bad.	-do-	-do-	N. Hawale.
19.	Shri Raghunath Agarwal, Beawar.	-do-	-do-	N. Balad.
20.	Shri Mangalchand Sethi Sanod.	-do-	-do-	N. Tilana.
21.	Shri Suganchand Mathur Beawar.	-do-	-do-	N. Naikalan.
22.	Shri J. K. Soniji, Hathi Bhatta, Ajmer.	-do-	-do-	N. Loharwara.
23.	Shri Shiv Nath Rai, Con- tractot, Gangori Bazar, Jaipur.	-do-	-do-	N. Dungarwara.
24.	M/s. Ramnarain Bros. Malakhera Gate, Alwar,	-do-	-do-	Alwar area.

1	2	3	4	5
25.	Shri H. P. R. Chowdhury Sarupganj.	Felspar	Mining leases	N. Thande.
26.	-do-	-do-	-do-	N. Sarupganj.
27.	Shri Chandu Lal Kushalchand Residency Road, Udaipur.	-do-	-do-	N. Banas.
28.	Shri Chandulal Gupta	-do-	-do-	N. Alwar-area.
29.	M/s. Nakimpex Traders, Bombay.	-do-	-do-	N. Kalinya.
30.	Sm. Vimla Rani Joshi, Ajmer.	-do-	-do-	N. Gawaja.
31.	Shri Moolchand Siroya, Babu Mohalla, Ajmer.	-do-	Prospecting License.	Rajgarh.
32.	Shri Madho Singh of V. Bhagwanpura, District Bhilwara.	-do-	-do-	N. Delana.

(d) List of Lease and Licence Holders for quartz.

1.	Shri J.K. Soniji, Ajmer	Quartz.	Mining leases.	N. Kalesra.
2.	Shri Ladoo Lal Kataria, Nasirabad.	-do-	-do-	N. Kalayanipura
3.	M/s. Aryan Industries, Ajmer.	-do-	-do-	N. Sarana.
4.	Shri R.D. Joshi, Beawar	-do-	-do-	N. Derathu.
5.	Shri Keshav Sen Kharwa, Ajmer.	-do-	-do-	N. Karwa.
6.	M/s. Gopilal Brij Raj, Beawar.	-do-	-do-	N. Rajgarh.
7.	M/s. Mohan Lal & Sons, Nasirabad.	-do-	-do-	N. Sanod.
8.	Shri Suganchand Mathur, Beawar.	-do-	-do-	Surdia.
9.	M/s. Gopi Lal Brij Raj, Beawar.	-do-	-do-	Dhawaji.
10.	Shri J. K. Sonoji, Hathi Bhatta, Ajmer.	-do-	-do-	N. Naddao.

1	2	3	4	5
11. M/s. Bharat Mineral Supply Corporation, Ajmer.	Quartz	Mining lease	N. Boraj.	
12. M/s. Chhittarmal Soni & Bros., Mohajhari, Ajmer.	-do-	-do-	N. Rajgarh.	
13. M/s. Mica Minerals Ltd., Ajmer.	-do-	-do-	N. Makrova.	
14. Shri Moolchand Siroya Ajmer.	-do-	-do-	N. Rajgarh.	
15. M/s. Chand Mal & Co., Kishangarh.	-do-	-do-	N. Nawoli.	
16. M/s. Sharda & Co., Nasirabad.	-do-	-do-	N. Nawale.	
17. Shri Raghunath Agarwal, Beawar.	-do-	-do-	N. Balad.	
18. Mangalchand Sethi, Sanod.	-do-	-do-	N. Tilana.	
19. Shri J. K. Soniji, Hathi Bhatta, Ajmer.	-do-	-do-	N. Loharwara.	
20. Shri H.P.R. Chowdhury, Sarupganj.	-do-	-do-	N. Sarupganj.	
21. Shri Chandulal Kushalchand Residency Road, Udaipur.	-do-	-do-	N. Banra.	
22. Parmanand Contractor, Dausa.	-do-	-do-	N. Dausa.	
23. Shri Komalchand Singhvi, Khunkhund.	-do-	-do-	N. Feori.	
24. M/s. Naktimpex Traders Bombay.	-do-	-do-	N. Kalinya.	
25. Shri H. P. R. Chowdhury, Sarupganj.	-do-	-do-	N. Moas.	
26. Shri Durga Prasad, Saboo, Khunkhund.	-do-	-do-	..	
27. Sm. Vimla Rani Joshi, Ajmer.	-do-	-do-	N. Gawaja.	
28. Shri Moolchand Siroya Babu Mohalla, Ajmer.	-do-	Prospecting license.	N. Rajgarh, P. 681, 4017.	

1	2	3	4	5
29.	Shri Madho Singh of Bhagwanpura District, Bhilwara.	Quartz	Prospecting license	N. Dolana.
30.	Shri Sheo Nath Rai Contractor.	-do-	-do-	N. Basued.
31.	Shri Nathoo Lal	-do-	-do-	N. Kiroti.

(e) List of Lease & Licence Holders for Kyanite.

1.	Shri Narain Prasad Purohit, Purani Basti, Jaipur.	Kyanite.	Mining lease.	N. Tunga.
2.	M/s. P. P. Singhal & Co., Udaipur.	-do-	-do-	N. Warsinghpura.
3.	Shri H. Sohanlal Jain, Mysori.	-do-	-do-	N. Khivandi.
4.	Shri Moolchand Nemi-chand, Naya Bazar, Ajmer	-do-	-do-	N. Buleani.
5.	Shri Narayan Prasad Purohit, Jaipur.	-do-	Prospecting license.	No. Tunga.
6.	Shri P. P. Singhal & Co., Udaipur.	-do-	-do-	No. Bhuali.
7.	Shri Hukam Singh Kachhawaha, Bhilwara.	-do-	-do-	N. Dungarwara.

(f) List of Lease and Licence Holders for Barytes.

1.	M/s. Ram Narain & Bros. Malakhera Gate, Alwar.	Barytes.	Mining lease	N. Bhurasidh.
2.	Shri Sohan Lal Vyas, Jaipur.	-do-	-do-	N. Gangoli.
3.	Shri Triloki Nath Consul, Alwar.	-do-	-do-	N. Singaupuri.
4.	M/s. Starke & Co., Kamla Market, New Delhi.	-do-	Prospecting licence.	N. Ghatla.

(g) List of Lease and License Holders in Soapstone

1.	M/s Mewar Industrial & Commercial Syndicate, Udaipur.	Soapstone	Mining lease	N. Lakhawali
2.	-do-	-do-	-do-	N. Rama Usan.
3.	Shri Moti Lal R. Minda, Mochjwara Udaipur.	-do-	-do-	N. Decpura.

1	2	3	4	5
4.	Shri Moti Lal R. Mindr, Mochiwara, Udaipur.	Soapstone	Mining leases	N. West Deopura
5.	-do-	-do-	-do-	N. Solaj.
6.	-do-	-do-	-do-	N. Parsola.
7.	-do-	-do-	-do-	N. Lohargarh
8.	M/s. A.K. Tehsin & Sons Moti Chohatta, Udaipur.	-do-	-do-	N. Chandeshra.
9.	M/s. Akbarali Ali Moham- med, outside Hathii Pole, Udaipur.	-do-	-do-	N. East of Negria
10.	Shri Motilal R. Minda Moti Chohatta, Udaipur.	-do-	-do-	N. Negria.
11.	-do-	-do-	-do-	N. Dheland.
12.	M/s Akbarali Ali Moham- med, Hathii Pole, Udaipur	-do-	-do-	N. Odwas.
13.	Shri Khan Mohammed Outside Hathipole, Udaipur.	-do-	-do-	N. Nawa.
14.	Shri Suresh Chandra Torhniwal, Tosniwal Street, Bhilwara.	-do-	-do-	N. Sembal & Kaora.
15.	Ram Ratan Mining Co. Fatehnagar.	-do-	-do-	N. Tarana.
16.	Shri Bansilal Chowdhary Hospital Road, Udaipur.	-do-	-do-	N. Harwar.
17.	M/s. Udaipur Mineral Development Syndicate, Bhilwara	-do-	-do-	N. Ghewasia, Chandapura and Bhagwasa.
18.	Shri Sri Kishan Agarwal, Neem-Ka-Thana, Sikar.	-do-	-do-	N. Khow.
19.	M/s Jaipur Mineral De- velopment Syndicate, Jaipur.	-do-	-do-	N. Dagotha, Jharana, Dausa.
20.	Shri H.P.R. Chowdhary, Sarupganj	-do-	-do-	No. Chilva.
21.	M/s. Moolchand Nemi- chand, Naya Bazar, Ajmer	-do-	-do-	N. Bubani.
22.	Shri R.D. Joshi, Beawar.	-do-	-do-	N. Rajgarh.

1	2	3	4	5
23.	M/s. Moolchand Nemichand, Naya Bazar, Ajmer.	Soapstone	Mining Leases	N.Rajgarh.
24.	Shri Shah Kastoor Mal, Sawaimansingh Highway, Jaipur.	-do-	-do-	N. Garhi Rajoli Kamalpur
25.	Shri Rameshwar Dass Sodhani, Jaipur.	-do-	-do-	N.Kalajpuri.
26.	M/s. Garg Mining Co. Fathnagar.	-do-	-do-	N.Sakroda.
27.	M/s. Mansinghka Bros, Bhilwara.	-do-	-do-	N.Sadipura.
28.	Shri Ambelal Siroya Delwara.	-do-	-do-	E.Eklinghi.
29.	Shri Kishan Agarwal.	-do-	-do-	N.Sanri.
30.	Shri Bansi Lal Chowdhari, Udaipur.	-do-	-do-	N.Malpura.
31.	M/s. Manrup Radha Kishan, Fatehnagar.	-do-	-do-	N.Lilzwa.
32.	Shri Abbas Akbarali, Udaipur.	-do-	-do-	N.Gogla.
33.	Shri H.P.R. Chowdhary Sarupganj.	-do-	-do-	N.Bhula.
34.	M/s. Akbarali Ali Mohammed, Udaipur.	-do-	-do-	N.Gunga Ka Guda.
35.	Shri H.P.R. Chowdhary, Sarupganj.	-do-	-do-	N.Turanji.
36.	Shri Ranjeet Lal Nalvaya, Udaipur.	-do-	-do-	N.Pathara-Ki-Pal.
37.	Shri Chuni Lal Dodia, Udaipur.	-do-	-do-	N.Gogla.
38.	M/s. Associated Soapstone Distributing Co., Station Road Udaipur.	-do-	Prospecting license.	N.Delva & Uto
39.	Shri Bansi Lal Chowdhury, Hospital Road, Udaipur.	-do-	-do-	N.Sayela.
40.	-do-	-do-	-do-	N.Kukra.