Opportunities for Value-added Chinaclay Projects in Gujarat

By

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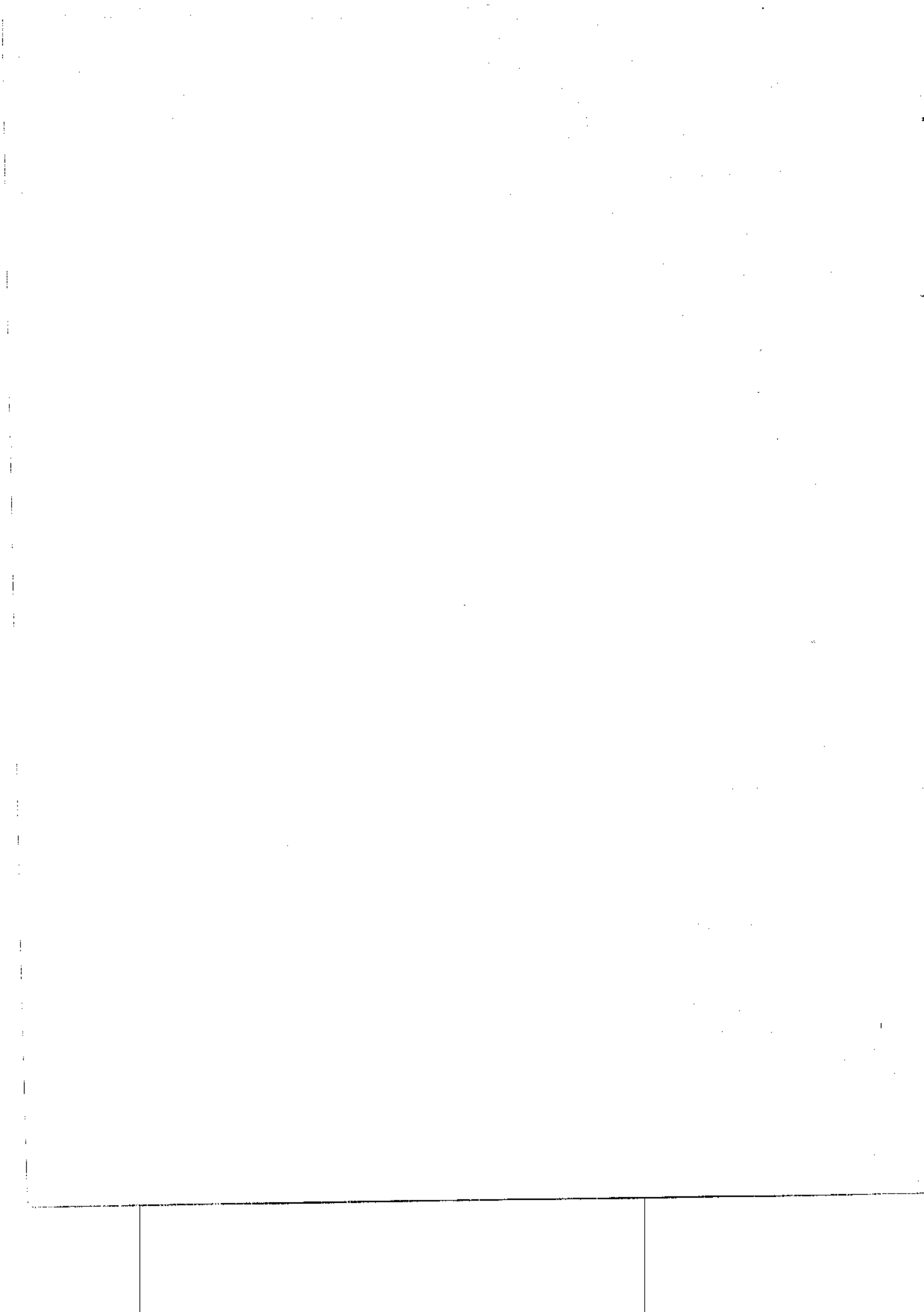

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SUMMARY AND CONCLUSIONS

- Total reserves of china clay and ball clay in India are estimated at 986 milion tonnes. Gujarat has potential of 63 million tonnes contributing share of about 9.2%.
- Districts of Sabarkantha, Mehsana and Kachchh are the main producing centres of Kaolin. The total reserves in state is 63 million tonnes. Production of refined china-clay is 9000 tonnes per annum. Thirty four leaseholders covering 72 hectares of land produces an average 20,000 tonnes of crude chinaclay per annum in the State.
- Out of fifteen levigation plants, two are in Sabarkantha district. The remaining are in Kachchh (12) and Mehsana(1). Scope for new techniques of beneficiation like high intensive electro magnetic separation, hydro cycloning, air floatation etc. are envisaged.
- Looking to the vast resources, maximum output of processed clay and its despatches, it is suggested that the potential locations for beneficiation with modern techniques should be in Sabarkantha, and Kachchh districts.
- In light of potentials of Kaolin, the other locations for setting up of beneficiation plants are suggested in the districts of Mehsana and Kachchh.
- More than 52% of china clay produced is utilised by various ceramic units. Refractory and Rubber industry consume about 16% and 9% respectively. Depending upon the item under manufacturing, the proprotionate use of china clay varies between 2% and 25%. 282 industrial units are reported using Kaolin in the country.
- About 60% of the total production in Gujarat is sent outside the State and rest 40% is utilized locally which amount to 6% of the total consumption of Kaolin in the country. The major consuming centres outside Gujarat are Delhi, Punjab, Maharashtra, Uttar Pradesh and West Bengal.
- On the basis of specification required by various units for the production of quality goods, units located in Gujarat have to procure china clay from state like Rajasthan and Kerala, aounting to 20% of its consumption. Pharmaceutical grade is procured from outside state by drug companies.
- During 1992, 72 leaseholders in Gujarat have accounted for production of 18.919 tonnes china clay.
- The export target for 1995-96 was 450 crore, during 1995, ninety crore worth Kaolin was exported. It was exported to Bangladesh, Kenya, Mauritius, UAE.
- Sabarkantha is considered a potential site for new applications. The suggested items are: H.T. Insulators, Porcelain, Piezo electric ceramics, Electronic ceramics, Electrolytic capacitors, etc. Sabarkantha has added advantage of falling under notified backward areas. The other sites for new applications are suggested in Mehsana and Kachchh districts.
- China clay value added products like calcined china clay, paper coating clay, levigation china clay and laminated china clay aproducts are identified. Profiles are prepared and sites are suggested.
- Techno-feasibility study for benefication of china clay is under progress in Ore-dressing Laboratory of Indian Bureau of Mines, Nagpur. The report with flow-sheet, plant and machinery data will be released shortly.

Preface

Fireclay, Chinaclay, Bentonite, Ballclay of Gujarat are well-known for ceramic, oil well drilling mud and pelletization applications in the clay market of the country. Detailed prospecting for chinaclay, bentonite have been carried out by Directorate of Geology & Mining, Government of Gujarat in Sabarkantha, Mehsana and Kachchh districts. The results have indicated 63 million tonnes chinaclay reserves and 110 million tonnes bentonite reserves in the State.

Conventional chinaclay levigation carried out by fifteen units needs a change in process technology. With a view to motivate modern processing techniques for benefication, iNDEXTb has signed MoU with Indian Bureau of Mines, Nagpur on 19th Jule, 1995. Ore Dressing Laboratory results are encouraging. Techno-feasibility benefication study report will be available after the pilot testing.

I am thankful to Director, Directorate of Geology & Mining, Govt. of Gujarat and Shri GM Rao, Ex-Ore Dressing Director, IBM, Nagpur for sparing chinaclay testing results and data.

To apprise chinaclay user agencies about the physico-chemical characters and its value added product profiles, present chinaclay status report compiled by Shri JV Bhatt, Senior Development Officer (Minerals) and Shri MM Parmar, Senior Officer (Minerals) under the guidance of Shri AK Ojha, General Manager (Tech.) will be useful reference publication and will work as a guideline for establishment of chinaclay value added products project in suggested locations.

I hope, the report will work as a reference literature for chinaclay users and entrepreneurs interested to go for processed minerals projects and export in the international market.

L Mansingh, IAS
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CHINACLAY OCCURENCES IN INDIA

Kaolin production is recorded from many countries but, only a few possess sizable deposits of coating quality kaolin. The major deposits are found in the USA, UK, Brazil and Australia, with smaller deposit in West Germany, France and Spain. Filler grade deposits are found in India, Romania, Czechoslovakia, Indonesia, Thailand, South Korea, China and USSR. The list of major kaolin producers in the world is given in table-1.

In India, about 14 states produce china-clay in larger or smaller quantities. Kerala stands first in production and rank. The all India total of recoverable reserves increased from about 872 million tonnes (1.1.1985) to about 896 million tonnes (1.4.1990) i.e. by 114 million tonnes. The predominant increase of about 93 million tonnes was in the ceramic pottery grade followed by insecticide grade with an increase of about 19 million tonnes. In the unclassified grade an increase of about 13 million tonnes and the chemical grade an increase of 6 million tonnes was recorded besides, an addition of 11 million tonnes in the others grade, 2.5 million tonnes in rubber grade and around 1 million tonne in the textile/paper grade, was also observed.

About 4 million tonnes have been kept under conditional resources. In 1.1.1985 there were 712 deposits and coverage in the inventory as on 1.4.1990 was 827 deposits, registering a net increase of 115 deposits.

Basis of Grade Classification

Around 1800 million tonnes of china clay reported in India has been classified keeping in view the BIS standards and current trends in consumption.

In the end use grade classificationfollowing grades are mainly given with their specifications. a) Ceramic, b) Textile and paper coating, c) Rubber, d) Paper filler and e) Insecticides

In addition the above chemical grade has also been included in the inventory.

Basis of Categorisation of Resources

China clay occurs in shallow depths. After mapping and surface examination, mainly by exploratory pitting, trenching and smapling, the reserve estimation are done. No specific pattern of spacing of the pits could be revealed by the inventory and it varies from one deposit to another. But by and large for the china clay deposit 80 m to 100 m spacing of pits or similar examination points forms the basis of estimation of the reserve in the 'proved category'.

Basis of Recoverable Reserves

As china clay occurs at shallow depths, the association of surface soil and other gangue materials is common. In adition, the unkaolinized portion of the host rock also constitutes the reject.

The overall recovery of all grades of reserve works out to around 56 per cent. In the ceramic and pottery grades, the recovery factor is found to be around 60% whereas in the insecticide grade it is found to be higher (around 80%).

Indian china-clay processing needs modernisation. All the deposits are to be prospected in details.Indian Bureau of Mines, Nagpur inventory reserves have been covered. Gujarat State's data has been updated.The all India reserve of China clay as on 1.4.1990 is given in table-2.

I
INTRODUCTION

Kaolin is one of the most versatile industrial materials. It is chemically in-ert over a relatively wide pH range, is white in colour and has good covering power when used as a pigment or extender. Kaolin is soft and non-abrasive, and has a low conductivity of heat and electricity. Some uses of kaolin, such as in paper coating, or fillers for paints and plastics require very rigid specifications including particle size, colour and brightness and viscosity whereas other uses require no specifications, for example in cement where the chemical composition is most important. The paper industry consumes the largest amount of kaolin where it is used both as a filler and as a coating material on the paper surface to improve the quality of printing.

The term "kaolin" is also used as a group name for mineral including kaolinite, nacrite, deckite and halloysite. Many authors, however, use the term kaolinite group. With the exception of the hydrated form of halloysite, all of these minerals have essentially the same composition. They differ in the mode of their structural arrangement. Kaolinite normally occurs as crystals ranging in size from a fraction of a micron up to several hundred microns across. Halloysite has the same composition as kaolinite with an additional sheet of oriented water molecules between the layers. In certain ceramic applications, halloysite has some advantages, but in most other cases its presence is neutral or disadvantageous. The presence of iron and titanium oxide minerals are disadvantageous as they impair whiteness and reduce brightness. The presence of excess silica in the form of quartz or cristobalite generally introduces abrasion problems in paper applications. The presence of micas and feldspar may influence the rheological, brightness and abrasion characteristics. The viscosity of the kaolin slurry is also affected by the presence of smectite.

Kaolins are generally classified as primary or secondary deposits. Primary kaolins are formed by the alterations of crystalline rocks such as granite and are found in the location where they are formed. Secondary kaolin deposits are sedimentary in nature and are formed by the erosion of primary deposits. As the eroded materials are washed down stream, separation takes place by gravity and particle size. The finer and lighter kaolin particles are carried further and eventually deposit in lakes, estuaries, and lagoons where secondary deposits may be formed. In primmary deposits, kaolin commonly makes up 15-30% of the total ore. the remainder of the ore consists of unaltered granite including quartz, muscovite and feldspar. Secondary deposits contain far more kaolinite, with the Georgia deposits containing 85-95% kaolin. In this case, the contaminants include quartz, muscovite, smectite, anatase, pyrite, and graphite.

Gujarat Kaoline deposits are derived from granite, felsphatic sandstone and pyroclasts. They are hydrothermmal or reworked deposits. Sabarkantha and Mehsana are hydrothermal pockets, where kaolinization is followed by laterization of the host rock granite. Kaolin pockets are irregular in shape-size. In altered and unaltered granite rock they occur as lensoid or augan shaped bodies. Reworked or sedimentary deposits are non gritty and bedded in nature. Directorate of Geology & Mining, Government of Gujarat has done prospecting work in Sabarkantha, Mehsana and Kachchh districts. Prospecting reports are available on a charge basis from the office.

Company	Location	Capacity	Remarks
Canada			
Ekaton Industries	Wood Mountain, Sask	150,000	
Chile			
Cemento Polpaico SA	Montengro	30,000	
France			
Kaolins d'Arvor	Ploemeur, Brittany	c.75,000	Paper(60%), ceramics(25%), paint, polymers, pharmaceuticals(15%).
Societe Kaoliniere Armoricaine-SOKA	Quessoy,Cote du Nord	c.120,000	Mostly ceramic grade clay. Sanitaryware (45%), tiles(35%), refractories(12%), polymers, glassfibre(8%).
Societe des Kaolins de Beauvoir	Vichy, Allier	20,000	Two ceramic grade clays produced. Plans for further capacity increase to 40-50,000 tpa and diversification into paper grade clays.
Societe des Kaolins du Finistere SA	Berrien, Brittany	50,000	Paper(60%, ceramics(40%).
Societe Nouvelle d'Exploitation des Kaolins du Morbihan	Lanvrian	70,000	Mostly ceramic clays. Sanitaryware(50%), tableware, porcelain(30%, paint, polymemrs(20%).
Ets Louis Perazio SA	Hostun, Bourg de Peage	8,000	Ceramic and filler grade kaolin for pigments and polymers.
SIKA SA-Produits Mineraux Siliceux du Sud-Est	Hostun, Drome	NA	
Germany			
Amberger Kaolinwerke GmbH	Hirschau-Schnaittenbach Bavaria	c.150,000	Paper(80%), ceramics ,paint, polymers(20%).
Basserman & Co.	Freihung	NA	
Gebruder Dorfner OHG, Kaolin und Kristallquarzsand Werke	Hirschau-Schnaittenbach, Bavaria	NA	Paper, fillers and coatings, ceramic and calcined clays.

attributed to the very fine-grained texture and the disseminated content of mixed layered clays and possibily in part to organic colloids.

All major occurrences are sedementary in origin. The common association with lignite and the occurrence of carbonaceous matter in the clay suggests a swampy environment of deposition such as a flood plain.

Worldwide occurrences of ball clay are primarily in Tertiary age rocks. There are no reported occurrences of ball clay in Palaeozoic rocks whereas plastic fire clays of Cretaceous age are very common. This age relation and the similarity in texture and mineralogy suggests that ball clays represent the earlier phase of fire clays that were produced by diagenetic changes.

Fire clay as defined includes a sequence of types from plastic to flint clay. they are often described as mebers of flint-clay facies representing progressive degrees of bleaching a d diagenesis. While no sharp distinction exists between the types, most often recognised types are plastic, semi-plastic, semi- flint, soft flint, hard flint and high alumina clay. From plastic to high alumina they are characterised by increasing alumina content, increased ordering of the kaolinite crystal structure and decreasing illite content. All of these variations plus the effect of 'impurities' such as iron oxide, pyrite, siderite, quartz, carbon and alkalies determine the physical properties and usefulness of each clay.

Flint clay is composed essentially of kaolinite, whereas semi flint and plastic fire clays contain increasing amounts of illite. The chemical composition of flint clay approaches that of kaolinite deviating to the extent of 'impurities'. The degree of ordering of the kaolinite varies from very well ordered in the harder flints to poorly ordered in the plastic clays. The texture of fire clays are extremely fine grained. Flint clay typically contained tightly compacted inter-locking systems. The texture of plastic clay is very similar to that of ball clay with semi-plastic or semi-flint being intermediate.

The physical properties of kaolinite, the principle constituent of china clay are as follows:

(1) Specific gravity : 2.60 to 2.63 (2) Bulk density on lbs/cu ft. : 20 to 40 (3) Hardness (Moh's scale) : 2.0 ro 2.5(4) Refractive index : 1.56 to 1.58 (5) Oil absorption (c.c. per 100 gm) : 25 to 50 (6) Water of plasticity (by weight) : 20 ro 40 (7) Reaction (pH) : 4.5 tot 7.0 (8) Green strength in kg/sq cm.: 5 to 20 (9) Linear dry shrinkage in percent: 3 to 8 (10) Linear (1400 ^{o}C) shrinkage in percent: 14 to 18 (11) Cation exchange capaicty (milli equivalents per 100 gm): 3 to 15 (12) Fusion teperature C^{o} : 1650^{o}C to 1775^{o}C.

Company	Location	Capacity	Remarks
Indonesia			
PT Alter Abadi	Tanjung, Belitung	c.50,000	Paper(50%, ceramic(40%), others(10%).
PT Baksmintraco	Bangka	c.2,000	
PT Kaolin Belitunga Utama	Tanjung	c.8,000	
PT Nepsia Martapura	Tanjung	c.8,000	
Perushaan Kaolin Palau Timah	Tanjung	c.7,000	
Italy			
Industria Chimica Carlo Laviosa SpA	Cagliari, Sardinia	NA	
Sardamin Srl	Torralba, Sardinia	NA	
Japan			
Kyoritsu Ceramic Materials Co. Ltd.	Tochigi	NA	
Mexico			
Refractories HW-Flir	Corralitos, Chic.		Refractory kaolin.
Nigeria			
Industrial Clays Nigeria Ltd		87,000	Ceramic and extender grade clays.
New Zealand			
New Zealand China Clays Ltd	North Island, NZ	25,000	High quality halloysite for ceramics.
Peru			
Minerals Andinos SA	Piura, Vichayal	1,000	Paper, paints, pesticides.
Philippines			
Anglo Enterprises Inc.	Laguna, San Pablo	c.1,200	
Portugal			
Abrigada-Cia Nacional de Refractories Sarl	Vila Nova le Gaia	NA	
Anglo Portuguesa de Caolines de Viana Ltd	Viana do Castello	40,000	Wholly owned subsidiary of ECCI producing paper grade kaolin.

Table 1

Major Kaolin Producers in the World

Company	Location	Capacity	Remarks
Argentina			
Geberovich Honos SSC	Rio Negro	NA	
Austria			
Aspanger Kaolin und Steinwerke AG	Aspanger	NA	-
Kamig-Osterreichische und Montaindustrie AG Nfg KG	Kreichbaum Weinzierl	50,000	Combined surface and underground production of paper & ceramic grade kaolin.
Australia			
Australian China Clays Ltd	Stubbo Tallawang	25,000	Ceramic grade clays.
Comalco Aluminium Ltd	Weipa, Queensland	c.100,000	Paper coating grade.
Commercial Minerals Ltd.	Gulgons, NSW	c.55,000	Ceramic grade clays.
Greenbushers Ltd	Greenbushes, WA		Plant proposed to provide 10-20,000 tpa.
Kaolin Australia Pty Ltd.	Pittong, Victoria	60,000	Wholly-owned by ECCI. Mostly paper coating and filler grades; some ceramic and polymer grades. Further expansion to 100,000 tpa is planned.
Kaomin NL	Ballarat, Victoria		Wholly-owned by ECCI.
Brazil			
Caolim Azzi Ltda	Mar de Espanha, MG	30,000	Paper 60%, paints 30%, misc.10%.
Caulim da Aamazonia SA	Munguba	300,000	Paper coating clay. New 50% expansion in capacity planned.
ECC do Brasil Mineracao Ltda	Sao Paulo	120,000	Paper coating clay.
Empressa de Mineracao Horii Ltda	Jundiapeba, SP	60,000	Ceramics 50%, fibreglass 20%, fertilisers 20%, misc. 10%.
Sinter Mor Mineracao Ltda	Guarda Mor, MG	NA	Refractory kaolin.
Talco Ouro Branco Ltda	Pariaba	10,000	

Company	Location	Capacity	Remarks
U.S.A.			
Albion Kaolin Co.	Augusta GA	300,000	Kaolin used in fibreglass, ceramics, soft rubber and refractories.
American Cyanamid	Andersonville, GA Benton, AR	100,000	Bauxite kaolin.
C-E Minerals	Andersonville, GA	200,000	Bauxitic and refractory grades kaolin.
ECC America	Sandersville, GA	>850,000	All grades of coating, delaminated and calcined clays. Plant expansion includes addition of fourth calciner.
Engelhard Corp.	Georgia	>1.3m.	All kaolin grades for paper, paint and polymers.
Evans Clay Co.	McIntyre, GA	180,000	Paper filler(32%), ceramics(22%), adhesives(18.6%), rubber(13.5%).
Feldspar corp EPK Clay Div.	Edgar, FL	50,000	Whiteware ceramics, including tiles, tableware, glazes and refractories.
Georgia Kaolin Co.	Dry Branch, GA Sandersville, GA Wrens, GA	600,000 800,000 120,000	All kaolin grades for paper, paint, polymers.
WR Grace & Co.	Aiken, SC	120,000	Airfloat kaolin for polymer extension and catalyst manufacture.
AP Green Refractories Co.	Little Rock, AR Macon, GA Latha County, ID	NA	Calcined refractory grade kaolin.
Harbison-Walker Refractories Co.	Eufala, AL	NA	Refractory grade bauxitic kaolin.

Company	Location	Capacity	Remarks
Erbsloh Geisenheim GmbH & Co.	Lohreheim, Oberwinter	NA	Paper, ceramic and filler grade kaolins.
Hutschenreuther AG	Tirschenreuth	c.20,000	Ceramic and filler grade kaolin.
Eduard Kick, Kaolin und Quarzsandwerke GmbH & Co.	Hirschau-Schnaittenbach, Bavaria	135,000	Mostly paper coating and filler grades, but also ceramic, calcined and extender grades of clay.
Otto Schmidt Kaolinwerke	Lohrheim, Aarbergen-Kettenbach	c.10,000	Paper(50%, polymers(25%), Chemicals(25%)
Greece			
Gamco-Gambino Co	Milos, Milos Island	NA	
Philkeram-Johnson SA	Lefkogia, Drama	c.100,000	Ceramic grade clay.
Silver & Baryte Ores Mining Co.	Milos, Milos Island Kefalos, Kos	c.30,000	Paper and extender grade clays.
Titan Cement SA	Milos Island	NA	For cement and fillers.
Varvatakis Al	Lefkogia, Drama	NA	
Petrochem K Zafranas SA	Milos Island	c.80,000	
Hungary			
National Ore & Mineral Mines	Mad	39,000	Mostly ceramic grade clay.
India			
M. Aikath	Singhbum, Bihar	c.10,000	Paper & polymer grade clay.
Apco Mineral Industries	Gujarat	c.10,000	Kaolin for paint, polymers and pharmaceuticals.
Ashapura Minechem Pvt Ltd	Kutch	c.11,000	Ceramic and refractory grade.
Bikaner Clays & Chemicals	Kolayat, Bikaner	1,000	Ceramics and polymers.
As Mathur & Co.	Kotputli, Jaipur	c.2,000	Ceramic and refractory grades.
Mysore Minerals Ltd	Gageshpur	c.1,500	
Ramkumar Singhania	Chanchbani	c.30,000	
West Coast Minerals & Chemicals	Bhimasar, Kutch	c.10,000	

Table 2
Reserve of China Clay as on 1.4.1990

Unit: 1000 tonnes

State		Reserve				Grade
		Proved	Probable	Possible	Total	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
All India	Institu	30567.2	513417.5	1223941.1	1767925.8	Total
		0.0	0.0	116.4	116.4	Textile/paper coating
		0.0	25.2	24724.4	24749.6	Insecticide
		600.0	1080.0	6250.0	7930.0	Chemicals
		19055.7	32868.6	135937.3	187861.6	Ceramics/Pottery
		31.0	28.0	1251.4	1274.4	Paper filler
		187.0	1773.0	4774.3	6734.3	Rubber
		10693.6	477642.7	1050923.3	1539259.6	Unclassified/Not known
	Recoverable	18975.9	291348.3	675645.2	985969.4	Total
		(19532.321)	(272550.978)	(579492.367)	(871575.666)	
		0.0	0.0	88.0	88.0	Textile/paper coating
		(207.450)	(0.0)	(712.880)	(920.330)	
		0.0	20.2	19684.2	19704.4	Insecticide
		(0.0)	(11.0)	(453.700)	(464.700)	
		500.0	950.0	5000.0	6450.0	Chemical
		(0.0)	(612.539)	(0.0)	(612.539)	
		13142.8	20695.9	94911.9	128750.5	Ceramics/porrery
		(3696.951)	(20312.194)	(11405.475)	(35414.622)	
		17.1	15.4	868.9	901.4	Paper filler
		(0.0)	(0.0)	(520.840)	(520.840)	
		131.0	1241.0	2044.8	3416.8	Rubber

Company	Location	Capacity	Remarks
Spain			
Arenas de Arija SA	Riodeva, La Yesa, Valencia	20,000	Paper filler and ceramic grades.
Caobar SA	Poveda, Guadalajara	20,000	Paper, ceramics, fibreglass, paints and polymers.
Caosil SA	Penalen, Guadalajara Villanueva de Alcoron	25,000	Paper filler, ceramics.
Caolines de Vimianzo SA(CAVISA)	Vimianzo	105,000	Paper filler clays.
Caolines y Silices SA	Penalen, Guadalajara	25,000	Paper filler clays.
Cia Espanola de Caolines SA (CEDECSA)	Poveda, Guadalajara	50,000	Paper coating grade(60%), paper filler (40%).
Explotacioners Ceramics Espanoles SA (ECESA)	Burela	70,000	Two ceramic grades.
Sri Lanka			
Ceylon Ceramics Corp.	Colombo, Galle	c.3-5,000	
Turkey			
Durmus Yasar ve Ogullari	Nigde	4,000	Paper(70%), plastics(20%), paint (10%0.
Matel Hammadde Sanayi ve Ticaret AS	Balikesir	20,000	Ceramic grade.
United Kingdom			
ECC International Ltd	St Austell, Cornwall Le Moor, Devon	>3.0 m.	Mostly paper grade clays, but includes ceramics, calcined & extended grades.
The Goonvean and Rostowrack China Clay Co. Ltd	St Austell, Cornwall	c.120,000	Paper(75%), ceramics(25%). New plans to increase output by 20,000 tpa by reactivating Trelavour pit.
Watts Blake Bearne and Co. PLC	Cornwood, Devon	c.130,000	Paper filler(40%), ceramic and extender grades (60%).
Steetley Minerals Ltd	St Austell	c.80,000	Paper filler, fibreglass and extender grades.

(1)	(2)	(3)	(4)	(5)	(6)	(7)
		0.0	2449.0	10975.1	13424.1	Unclassified/Not known
		(72.477)	(743.215)	(16187.226)	(17002.918)	
Assam	Insitu	3970.0	0.0	160.0	4130.0	Total
		3970.0	0.0	100.0	4070.0	Ceramics/pottery
		0.0	0.0	60.0	60.0	Unclassified/Not known
	Recoverable	3054.0	0.0	96.0	3150.0	Total
		(3610.800)	(0.0)	(86.766)	(3697.66)	
		3054.0	0.0	60.0	3114.0	Ceramics/pottery
		(-)	(-)	(-)	(-)	
		0.0	0.0	36.0	36.0	Unclassified/Not known
		(3610.800)	(0.0)	(86.766)	(3697.566)	
Bihar	Insitu	5743.3	18313.5	278913.4	302970.2	Total
		0.0	29.3	38.3	67.6	Ceramics/pottery
		0.0	0.0	13.3	13.3	Rubber
		5743.3	18284.2	278861.7	302889.3	Unclassified/Not known
	Recoverable	981.9	2065.8	31379.9	34427.5	Total
		(4033.045)	(1783.211)	(35969.414)	(41785.670)	
		0.0	20.5	15.8	36.3	Ceramics/pottery
		(30.100)	(0.0)	(49.880)	(79.980)	
		0.0	0.0	2.0	2.0	Rubber
		(0.0)	(0.0)	(2.0)	(2.0)	
		-	-	-	-	Textile/paper coating
		(207.450)	(0.0)	(703.130)	(910.580)	
		981.9	2045.3	31362.0	34389.2	Unclassified/Not known
		(3795.495)	(1783.211)	(35214.404)	(40793.110)	

Company	Location	Capacity	Remarks
JM Huber Corp.	Huber, GA Wrens, GA Edisto, SC Langley, SC	>1m.	All kaolin grades, but mostly paper coating clays.
Kentucky-Tennessee Clay Co.	Sandersville, GA Aiken, SC	280,000	Airfloated ceramic and filler grades.
Nored Kaolin Co.	Jeffersonville, GA	300,000	Paper coating, filler and delaminated grade clays.
North American Refractories Co.	Ione, CA	60,000	Calcined, ceramic and filler grade clays.
Standard Industrial Minerals Inc.	Bishop, CA	13,000	Extender grade clay for paints, adhesives and cement.
Thiele Kaolin Co.	Oconee, Deepstep Thomson, GA	1.25m.	Paper coating, filler and extender grades for polymers.
RT Vanderbilt Co. Inc.	Bath, SC	NA	Paper filler & ceramic grade clays.
US Silica Co.	Kosse, TX	NA	Polymer extender.
Wilkinson Kaolin Associates Ltd	Gordon, GA	250,000	Paper filler, ceramic and extender grade airfloated.

Source: Industrial Clays - A special review, June 1989.

(1)	(2)	(3)	(4)	(5)	(6)	(7)
		(-)	(-)	(-)	(-)	
		0.0	778.1	2273.3	3051.4	Unclassified/Not known
		(0.0)	(1711.950)	(2071.870)	(3783.820)	
Haryana	Insitu	279.2	472.4	2053.2	280.8	Total
		266.0	438.0	1930.0	2634.0	Ceramics/pottery
		13.2	34.4	123.2	170.8	Unclassified/Not known
	Recoverable	228.0	409.0	1610.0	2247.6	Total
		(24.0)	(66.0)	(419.0)	(509.0)	
		224.0	394.0	1544.0	2162.0	Ceramics/pottery
		(-)	(-)	(-)	(-)	
		4.0	15.6	66.0	85.0	Unclassified/Not known
		(24.0)	(66.0)	(419.)	(509.0)	
Jammu &	Insitu	0.0	0.0	28121.6	28121.6	Total
Kashmir		0.0	0.0	28121.6	28121.6	Unclassified/Not known
	Recoverable	0.0	0.0	19654.5	19654.5	Total
		(0.0)	(0.0)	(19640.910)	(19640.910)	
		0.0	0.0	19654.5	19654.5	Unclassified/Not known
		(0.0)	(0.0)	(1964.910)	(19640.910)	
Karnataka	Insitu	58.0	4113.9	21615.2	25787.1	Total
		0.0	0.0	116.4	116.4	Textile/paper coating
		0.0	0.0	2142.0	2142.0	Insecticide
		0.0	113.0	147.0	260.0	Ceramics/pottery

(1)	(2)	(3)	(4)	(5)	(6)	(7)
		(0.0)	(560.0)	(269.620)	(829.620)	
		5185.1	268425.9	553047.3	826658.3	Unclassified/Not known
		(15627.918)	(251055.245)	(566129.852)	(832813.015)	
	Conditional	5.0	. 3304.0	2647.3	5956.3	Total
		2.9	5.3	26.3	34.5	Ceramics/pottery
		2.1	3298.7	2621.0	5921.8	Unclassified/Not known
Andhra	Insitu	232.3	3526.2	60715.0	64473.5	Total
Pradesh		0.0	25.2	22326.4	22351.6	Insecticides
		0.0	0.0	6250.0	6250.0	Chemicals
		232.3	445.0	17166.8	17844.1	Ceramics/pottery
		0.0	0.0	1137.5	1137.5	Paper filler
		0.0	0.0	400.0	400.0	Rubber
		0.0	3056.0	13434.4	164904.4	Unclassified/Not known
	Recoverable	227.7	2881.2	48235.3	51344.2	Total
		(289.277)	(849.615)	(22444.706)	(23583.598)	
		0.0	20.2	17872.2	17892.4	Insecticides
		(0.0)	(0.0)	(453.700)	(453.700)	
		0.0	0.0	5000.0	5000.0	Chemicals
		-	-	-	-	
		227.7	412.0	13227.1	13866.8	Ceramics/pottery
		(216.800)	(106.400)	(5303.780)	(5626.980)	
		0.0	0.0	840.9	840.9	Paper filler
		(0.0)	(0.0)	(500.000)	(500.000)	
		0.0	0.0	320.0	320.0	Rubber
		-	-	-	-	

(1)	(2)	(3)	(4)	(5)	(6)	(7)
		(-)	(-)	(-)	(-)	
		0.0	2596.8	87618.6	90215.4	Unclassified/Not known
		(0.0)	(3907.370)	(85490.550)	(89397.920)	
Madhya	Insitu	600.00	2976.9	14228.9	17805.7	Total
Pradesh		600.00	1080.0	0.0	1680.0	Chemical
		0.0	106.0	55.1	161.1	Ceramics/pottery
		0.0	1790.9	14173.7	15964.6	Unclassified/Not known
	Recoverable	500.0	2614.5	11596.4	14710.9	Total
		(0.0)	(3186.227)	(14765.291)	(17951.518)	
		500.0	950.0	0.0	1450.0	Chemicals
		(0.0)	(610.619)	(0.0)	(610.619)	
		0.0	103.9	44.0	147.9	Ceramics/pottery
		(0.0)	(148.798)	(55.090)	(203.888)	
		0.0	1560.6	11552.4	13113.0	Unclassified/Not known
		(0.0)	(2426.810)	(14710.201)	(17137.011)	
Maharashtra	Insitu	0.0	475.3	3620.1	4095.4	Total
		0.0	337.4	0.0	337.4	Ceramics/pottery
		0.0	0.0	2.0	2.0	Rubber
		0.0	137.9	3618.1	3756.0	Unclassified/Not known
	Recoverable	0.0	399.4	2649.6	3049.0	Total
		(0.0)	(427.100)	(2830.739)	(3257.839)	
		0.0	269.9	0.0	269.9	Ceramics/pottery
		(0.0)	(275.0)	(0.0)	(275.0)	
		0.0	0.0	1.6	1.6	Rubber
		(0.0)	(0.0)	(1.620)	(1.620)	

(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Conditional	0.0	0.0	13.0	13.0	Total
		0.0	0.0	13.0	13.0	Unclassified/Not known
Delhi	Insitu	358.0	694.9	4425.5	5478.4	Total
		332.0	408.00	1139.0	1879.0	Ceramics/pottery
		26.0	286.9	3286.5	3599.4	Unclassified/Not known
	Recoverable	337.4	619.9	4116.7	5074.0	Total
		(420.987)	(887.764)	(4338.650)	(5647.401)	
		312.7	347.4	994.8	1654.8	Ceramics/pottery
		(-)	(-)	(-)	(-)	
		24.7	272.6	3122.0	3419.2	Unclassified/Not known
		(420.987)	(887.764)	(4338.650)	(5647.405)	
Goa	Insitu	0.0	16.0	0.0	16.0	Total
		0.0	16.0	0.0	16.0	Unclassified/Not known
	Recoverable	0.0	15.0	0.0	15.0	Total
		(0.0)	(15.0)	(0.0)	(15.0)	
		0.0	15.0	0.0	15.0	Unclassified/Not known
		(0.0)	(15.0)	(0.0)	(15.0)	
Gujarat	Insitu	0.0	3112.7	36342.0	39454.6	Total
		0.0	0.0	27695.0	27695.0	Ceramics/pottery
		0.0	3112.7	8647.0	11759.7	Unclassified/Not known
	Recoverable	0.0	778.1	24429.4	25207.5	Total
		(0.0)	(1711.950)	(2071.870)	(3783.820)	
		0.0	0.0	22156.0	22156.0	Ceramics/pottery

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Pondichrry	Insitu	0.0	0.0	2940.0	2940.0	Total
		0.0	0.0	2940.0	2940.0	Unclassified/Not known
	Recoverable	0.0	0.0	2352.0	2352.0	Total
		(0.0)	(0.0)	(2352.0)	(2352.0)	
		0.0	0.0	2352.0	2352.0	Unclassified/Not known
		(0.0)	(0.0)	(2352.0)	(2352.0)	
Rajasthan	Insitu	13885.6	18700.9	233793.0	266379.5	Total
		0.0	0.0	256.0	256.0	Insecticides
		10102.9	13551.7	17437.9	41092.5	Ceamics/pottery
		3782.7	5149.3	216099.0	225031.0	Unclassified/Not known
	Recoverable	10574.5	13220.2	184829.2	208623.9	Total
		(9102.668)	(19351.604)	(179618.040)	(208072.312)	
		0.0	0.0	205.0	205.0	Insecticides
		(-)	(-)	(-)	(-)	
		6928.5	8299.2	14265.7	29493.3	Ceramics/pottery
		(3450.053)	(11637.056)	(5273.315)	(20360.424)	
		-	-	-	-	Chemical
		(0.0)	(1.920)	(0.)	(1.920)	
		3464.0	4921.1	170358.5	178925.6	Unclassified/Not known
		(5652.615)	(7712.628)	(174344.725)	(187709.968)	
	Conditional	0.0	104.0	340.0	444.0	Total
		0.0	104.0	340.0	444.0	Unclassified/Not known
Tamil Nadu	Insitu	0.0	198.3	56643.1	56841.4	Total
		0.0	0.0	551.9	551.9	Ceramics/pottery
		0.0	198.3	56091.2	56289.5	Unclassified/Not known

(1)	(2)	(3)	(4)	(5)	(6)	(7)
		31.0	28.0	59.9	118.9	Paper filler
		0.0	0.0	4359.0	4359.0	Rubber
		27.0	3972.9	14791.1	18791.0	Unclassified/Not known
	Recoverable	41.0	3026.8	13712.1	16780.0	Total
		(0.0)	(4856.110)	(6088.220)	(10944.330)	
		0.0	0.0	88.0	88.0	Textile/paper coating
		(0.0)	(0.0)	(9.750)	(9.750)	
		0.0	0.0	1607.0	1607.0	Insecticide
		(0.0)	(11.0)	(0.0)	(11.0)	
		0.0	105.0	122.5	227.5	Ceramics/pottery
		(0.0)	(1397.0)	(41.800)	(1438.800)	
		17.1	15.4	20.8	53.3	Paper filler
		(0.0)	(0.0)	(20.840)	(20.840)	
		0.0	0.0	1721.2	1721.2	Rubber
		(-)	(-)	(-)	(-)	
		24.0	2906.4	10152.6	13083.0	Unclassified/Not known
		(0.)	(3448.110)	(6015.830)	(9463.940)	
Kerala	Insitu	242.1	5439.0	124681.4	130362.5	Total
		242.1	2321.30	3115.0	5678.1	Ceramics/pottery
		0.0	3118.0	121566.4	124684.4	Unclassified/Not known
	Recovereable	181.6	4352.7	89931.4	94465.7	Total
		(0.0)	(3907.370)	(85490.550)	(89397.920)	
		181.6	1755.9	2318.7	4250.2	Ceramics/pottery

IV
CHINACLAY OCCURRENCES IN GUJARAT

Recently, Gujarat china clay has entered in the international market. China clay was exported from Kandla port. China clay of Gujarat has occupied market in Bombay, Haryana and U.P.

From geological considerations, State have both residual and transported deposits. Hydrothermal granite alteration type of kaolin deposits are encountered in river Sabarmati in Himatnagar, Sabarkantha, Banaskantha and Mehsana districts. These deposits are located around village Eklara, Arsodia, Kot and Ransipur. The history of exploitation of these deposits dates back quite a long time.

The sedimentary kaolin deposits are encountered as detailed below:

Wankaner and Morvi Clays in Rajkot and Surendranagar Districts

Geologically speaking the cluster of Rajkot and Surendranager clays are sedimentary clays belonging to the upper Gondwana system. A small review by Dr. Talati and Mr. Desai (1977) has shown that variety of kaolin group of clays are encountered in these areas.

A number of clay bands and shale have been noticed. The clay formation of areas like Morvi, Wankaner, Dhrangadhra, Tarnetar, other than Khakharathal and Than have been known for refractory and ceramic properties.

Than clay has been studied qualitatively by Mr. Ghosh et al (1962), Mr. Bishui and Mr. Prasad (1965) Mr. Ghosh et al made laboratory studies for Than and Bagagala clays. Properties like colour, visible impurities, slaking, screen test, water of plasticity, fired properties at cone 7 and cone 17 including linear shrinkage colour, vitrification. Chemical analysis, DTA and particle size distribution were also carried out. The results revealed that as compared to the imported plastic clays (ball clays), Than and Bagagala clays had higher silica content, lower alumina content and the colouring oxides were on the higher side. Than-Bagagala clays differ from one another in having different bleaching oxides. The particle size distribution shows that both Than and Bagagala clays had lesser fine sized particles and it was suggested that simple washing process can be applied to these clays to improve the finess, plasticity and other physical properties.

Accoding to Arogyaswami (1968), grey coloured refractory clay occurs at about 800 m. north west of Velala over an area of about 426 sq. kms. The bed is 0.6-0.9 m. thick and underlies variegated sandstone andmottled clay with a total thickness of 1.5 to 3 m. The clay appears to be of limited extent. The material is highly plastic and shows slight vitrification at 1450^{0}C with a shrinkage of 15% and the colour is dull grey.

At Udepur near Makansar a bed of grey highly plastic clay, about 0.90 m to 1.5 m. thick, occurs over area of nearly 5 sq. kms. When fired to 1150^{0}C, the material shows fair vitrification.

A bed of thick carbonaceous clay, about 1.2 to 1.5m. thick, occurs near Raphaleshwar. The clay is lightly plastic with a shrinkage of 8% at 1450^{0}C and without vitrification.

From thet above results, it is apparent that most of the samples burnt white, have high plasticity, high shrinkage and show vitrification below the teperature of 1600 ^{0}C. Thus, they are not fire clays in strict sense (except for Raphaleshwar clays which have physical properties near to fire clay).

The nomenclature for many of them require revision on scientific basis. The existing ceramic and refractory units in the vicinity take advantage of variation of physical properties to

(1)	(2)	(3)	(4)	(5)	(6)	(7)
		0.0	129.5	2648.0	2777.5	Unclassified/Not known
		(0.0)	(152.100)	(2829.119)	(2981.219)	
Meghalaya	Insitu	2750.0	3740.0	80772.3	87262.3	Total
		2750.0	3240.0	65443.3	71433.3	Ceramics/pottery
		0.0	500.0	15329.0	15829.0	Unclassified/Not known
	Recoverable	1650.0	2110.0	48603.1	52363.1	Total
		(0.0)	(4972.970)	(46113.350)	(51086.320)	
		1650.0	1810.0	39266.0	42726.0	Ceramics/pottery
		(0.0)	(0.0)	(267.320)	(267.320)	
		0.0	300.0	9337.1	9637.1	Unclassified/Not known
		(0.0)	(4972.970)	(45846.030)	(50819.0)	
Orissa	Insitu	365.2	111445.8	199026.5	310837.6	Total
		101.8	318.2	642.4	1062.4	Ceamics/pottery
		0.0	0.0	18.0	18.0	Paper filler
		187.0	1773.0	0.0	1960.0	Rubber
		76.4	109354.6	198366.2	307797.2	Unclassified/Not known
	Recoverable	179.9	59662.9	97539.4	157382.2	Total
		(0.0)	(35494.200)	(58309.190)	(93803.390)	
		27.5	85.9	192.7	306.1	Ceramics/pottery
		(-)	(-)	(-)	(-)	
		0.0	0.0	7.2	7.2	Paper filler
		(-)	(-)	(-)	(-)	
		131.0	1241.0	0.0	1372.0	Rubber
		(0.0)	(560.000)	(266.000)	(826.000)	
	Conditional	0.0	0.0	1589.0	1589.0	Total
		0.0	0.0	1589.0	1589.0	Unclassified/Not known

Fired Properties

Properties	Fired at 1100°C	Fired at 1250°C	Fired at 1400°C
Fired colour and visual examination.	Dull white, pals white and white with slight pink tings. No cracks or specks visible.	Yellowish white to white, no cracks or specks visible.	Yellowish white brown specks visible but no cracks other clays show yellow upper surface with grey patches no cracks visible.
Linear shrinkages	8.0 to 11.0%	8.0 to 11.0%	10.0 to 15.0%
Water absorption	12.77 to 16.77%	12.14 to 16.59%	10.0 to 15.0%
Vitrification	None	None to fair	None to fair

The PEC was taken for the Surendranagar and Rajkot district clays. It was found that all the clays are suitable as a moderate heat duty fire clay refractories raw material as per IS - 7-1967.

The clays can be used for sanitarywares, stonewares, whiteware industries for high temperature. They are suitable as refractory raw material as per IS-7-1967.

Kachchh District China clay

The details of geological conditions of these blocks are very siilar to the Rajkot-Surendranager areas. Thus, they belong to the continental formation of the Upper Gondwana of Kachchh. Recently, Dr. Talati and Mr. Parikh (1982) have given a detailed account of the Upper gondawana of Kachchh and have shown that there are number of clay horizons and most of the horizons as they belong to continental deposit in acidic conditions belong to kaolinite group. The total area explored are of Upper Gondwana is of the order of 4000 sq. kms. The State Dept. has done prospecting in Sukhapar, Mamuara deposits. The prospecting reports are available on a charge basis. The list is given in Annexure-XIV. Chinaclay conventional legivation plants are in operation in Bhuj & Madhapur GIDC.

Properties of Kachchh China Clay

The occurrence of china clay has gained commercial importance. Recently, few mining leases have been granted. The samples were examined by the Central Glass and Ceramic Research Institute (1) (CGCRI). i) The clay from Sakranadi deposit in Anjar taluka was dull white, fairly plastic and on firing at 1400°C showed pale cream colour and absence of any vitrification. The clay may be considered suitable for pottery and refractories. ii) The clay fromm near Dagla in Anjar taluka was grey in colour, plastic and on firing at 1400°C exhibited grey colour with a fair degree of vitrification. iii) They clay from north of Hirapur in Anjar taluka was dull white and fairly plastic. Its fired colour at 1400°C was white with a few coloured specks and showed no vitrification. iv) The clay from near Mamuara in Bhuj taluka was mixed dull white and pink in raw state fairly plastic on firing at this showed a pale cream colour with severe fired specks without any vitrification. v) The clay from near Asambia in Mandvi taluka was cream with brown specks and streaks in raw state fairly plastic and the fired colour at 1400°C was between

(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Recoverable	0.0	138.8	44857.8	44996.6	Total
		(420.968)	(410.625)	(45386.663)	(46218.256)	
		0.0	0.0	462.2	462.2	Ceramics/pottery
		(0.0)	(0.0)	(414.290)	(414.290)	
		0.0	138.8	44395.5	44534.3	Unclassified/not known
		(420.968)	(410.625)	(44972.373)	(45803.966)	
Uttar	Insitu	0.0	0.0	17.8	17.8	Total
Pradesh		0.0	0.0	17.8	17.8	Unclassified/Not known
	Recoverable	0.0	0.0	12.5	12.5	Total
		(0.0)	(0.0)	(12.450)	(12.450)	
		0.0	0.0	12.5	12.5	Unclassified/Not known
		(0.0)	(0.0)	(12.450)		
West	Insitu	2083.6	340191.6	75872.3	418147.5	Total
Bengal		1058.6	11561.0	475.0	13095.1	Ceramics/pottery
		1025.0	328630.7	75396.7	405052.4	Unclassified/Not known
	Recoverable	1020.0	199053.4	50040.1	250113.4	Total
		(1630.576)	(194631.232)	(53463.158)	(249724.966)	
		546.8	7092.3	248.4	7877.4	Ceramics/pottery
		(0.)	(6747.940)	(0.0)	(6747.940)	
		483.2	191961.1	49791.8	242236.0	Unclassified/Not known
		(1630.576)	(187883.292)	(53463.158)	(242977.026)	
	Conditional	5.0	3200.0	705.3	3910.3	Total
		2.9	5.3	26.3	34.5	Ceramis/pottery
		2.1	3194.7	679.0	3875.8	Unclassified/Not known

Source: Monograph - Chinaclay : Indian Bureau of Mines, Nagpur.

manufacture different fired articles like crockery, fire bricks, roofing tiles, L.T. pressed insulators, artware pottery, stoneware pipes and fittings etc.

Kathiara R.S (1974) observed the occurrences of fire clay (impure china clay) in Khakhrathal, Than villages of Surendranagar district and estimamted reserves occuring above the coal seams in Than area in six blocks proving reserves of 97,47,000 tonnes. The basic properties indicate that there is fairly good chance of applying modern techniques to upgrade the material.

Properties of Rajkot/Surendranager District Clays:

Physical Properties:

The raw colour is dark grey white to greyish white. The grey colour is due to associated impurities of carbonaceous mmatter. The slaking nature is slow to moderate. All the clays showed alkaline pH. The base exchange capacity showed that all the clays contain kaolinite. Screen test showed that Muli and Sadla clays contain low residue while Ranipat clay contains high residue but as its slaking nature in slow to non slaking hence, high percent of residue is due to undispersed clay. The determination of loss on ignition also confirms that all the residues on 150 B.S sieve contains most of clay and carbonaceous matter.

Green Properties:

Plasticity was reported by hand feeling. Few clays show fair plasticity due to associated organic matters. The degree of plasticity is also confirmed by the Atterberg's number. The dry linear shrinkakge is comparatively low.

Chemical Analysis:

SiO_2 : 61.00 to 64. 55% Al_2O_3 : 22.76 to 24.25% Fe_2O_3 : 0.48 to 1.12% TiO_2 : 0.62 to 0.77% CaO : 1.00 to 1.14% MgO : Traces Na_2O : 0.12 to 0.52% Na_2O : 0.12 to 0.52% K_2O : 0.36 to 0.68% LOI : 7.65 to 0.70%.

Looking to the above chemical analytical results, clay contains tolerable impurities of Fe2O3, TiO_2 and CaO. The SiO_2 is high compared to Al_2O_3 content. Generally, the characteristic of chemical analysis indicates that the clay content is silicoeous kaolinite.

Fired Properties:

For fire clay, the fired properties are the essential characteristics. The test pieces were fired at 1100°C, 1250°C and 1400°C. After each firing, the fired properties were studied which are shown in the following table:

of the kaolin. Secondly, most of the areas are covered by private leases and also substantial area lies in private agriculture land. Thus, for a scientific large scale beneficiation plant, new agency has very little chance of economic operation. The existing mine owners may be persuaded to consider modern procesing of china clay.

Properties of Sabarkantha and Mehsana China Clays

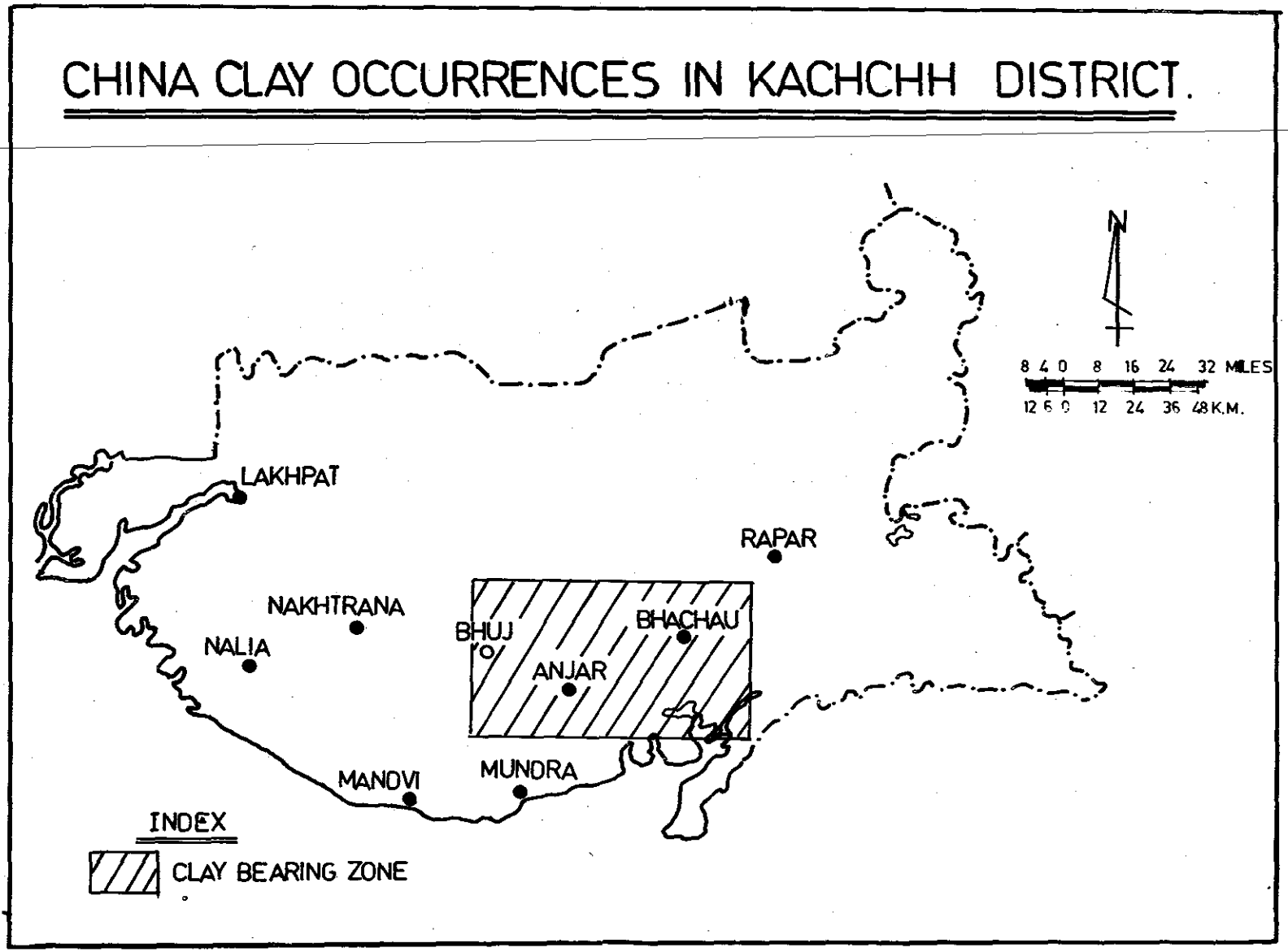
Central Glass and Ceramic Research Institute have conducted testing on representative saples collected from a few working mines located in Arsodia and Eklera villages of Sabarkantha district (Annexure-V) and Kot, Ransipur areas of Mehsana district (Annexure-VI). The samples fro different places were found to be more or less siilar in nature and the average yeild of refined clay on beneficiation was about 40%. The processed clay was white to pale white in colour possessing good plasticity and workability. The clays were calcined at $1400^{o}C$ and fired colour varies between white and pale white without any vitrification. Average cheical constituents of the processed clay were SiO_2 - 46.00, Al_2O_3 - 37.70, Fe_2O_3 - 0.57, TiO_2 - 0.70, CaO - 0.76, MgO - 0.18 (K_2O + Na_2O), LOI - 14%. Mineral constituents were kaolinite 96%, free quartz 1.5% and others 2.5%.

The results of their exainations revealed that the china clays available from these areas could be classified in three distinct groups, depending mainly on location of the deposit and physical characters of the clay. The clays under group -I are good quality china clays amenable to washing. The yield on washing varies between 30% to 40%, the washed clays are white to pale white in colour and possess moderate to good plasticity. The fired colour varies from white to light cream. These clays are considered promising for whitewares. The clays under group -II are inferior in quality to those under group - I. The yield of clay on washing is about 35%. Plasticity is good but fired colour is slightly on the darker side and as such the clays are suitable only for those ceramic products for which fired colour is not very important. The clays falling under group -III are mostly impure type of clays, the quality of which can not be improved, by just washing and such clays are considered unsuitable for ceramic, whitewares but suitable for heavy clay products. At present, two companies are engaged in mining and processing of china clay in Sabarkantha and Mehsana districts. The processing in all the plants is done by wet sedimentation method. Likewise levigation plants in Kachchh are also under operation.

iNDEXTb has signed a MOU with Ore-dressing Laboratory of Indian Bureau of Mines for beneficiation study of China clay, Silica sand, Chalk & Bentonite. Pilot plant testing and techno-feasibility tests for the above area clay has been carried out by the Laboratory. Interim beneficiation results indicate that clay can be beneficiated for the paper grade. The pilot study will be taken up for the deposit. Interim results received is mentioned in Annexure-IX.

At present,"20 Micron" company at Wagodia GIDC in Baroda district process micro-china by water washed, calcined, airfloated & surface treated methods. Unique surface treatment by micro-coating process provides superior hydrophobicity, excellent dispersion and chemical reactivity in many polymer systems.

CHINA CLAY OCCURRENCES IN KACHCHH DISTRICT.



pale cream and light grey with slight vitrification.(Annexure-I)

Devka, Rajula clays in Amreli District

White clay saples are being collected for further tests. (Annexure-II)

Jhagadia, Valia and Bardoli in Bharuch and Surat Districts

The occurrences of china clays in the districts of Surat and Bharuch are reported to be of minor importance from comercial point of view. Recently, a few mining leases for clays have been granted in these areas.

Rajpardi clay of Bharuch District

The Rajpardi clay is available in plenty as an overburden in the lignite deposit situated at Bhoori village in Bharuch district. The mine is operated by Gujarat Mineral Development Corpn. Rajpardi clay contains residue of about 0.6% on 45 micron 15 sieve whereas Bikaner clay containthe same to about 6.73%. Other properties like water of plasticity, workability and dry strength are quite good and higher than that of Bikaner and Than clays. Centre Glass & Ceramic Research Institute (Naroda Centre), Ahmedabad has carried out detailed application study to replace Bikaner clay in low-tension insulators, glazed wall times, crockerywares, sanitaryware, refractory products. The results are encouraging. Product manufacturers can utilise Rajpardi clay in place of Bikaner clay in certain proportion to reduce the cost. The Physico-chemical analysis of Rajpardi clay is given at Annexure-III. An abstract of the papers presented during workshop in March '96 are given in a separate chapter titled Profiles.

Aluvas and Dhokawada of Santalpur taluka of Banaskantha District

The good quality clays are reported in Santalpur areas of Banaskantha district. The detail testings are required to be carried out on top priority basis. The available analysis are given under Annexure - IV.

There is another group of china clay occurrences which do not fall in the above categories, but as part and parcel of the under clays associated with the process of lateritisation. Such clays are termed as lithomarge, but its consists of kaolinite group of clays attained high degree of purity and whiteness. Some time they contain impurities of gibbsite which may improve upon the alumina content of the clays thereby increasing their intrinsic value of ceramic purpose.

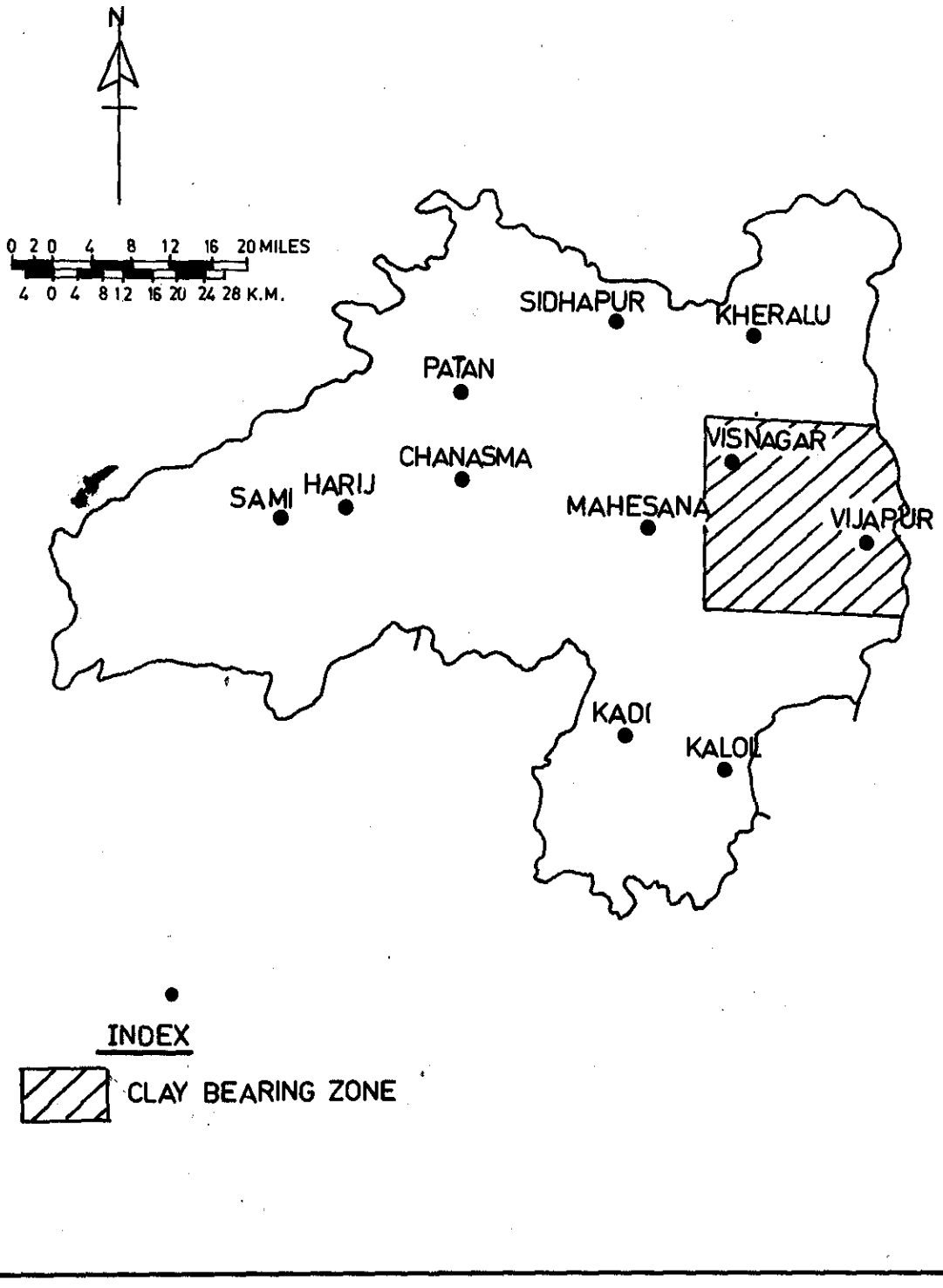
Lithomarge of Kachchh District:

The deposit occurs 1.6 km. south of Wandh, 45 kms. fromm Bhuj railway station. The deposit is a lithomargic clay band of 0.9 m. thick and spread over 17,000 sq. mts. When examined at CGCRI, the clay showed a dark cream colour with very good plasticity and fired to light buff colour at 1400^{o}C with fair vitrification. The clay was considered suitable for refractories.

Potentials at Sabarkantha and Mehsana clay

State Directorate of Geology and Mining had carried out detailed exploration by drilling near villages of Eklara, Davad, Arsodia, Kot and Ransipur, Rampur, Pedhmali etc. and proved 62.15 million tonnes of good quality of china clay. The deposits appear to be irregular in thickness and occur at different depths in their sub surface continuity. Thus, large scale production from these mines by mechanical means is not feasible. The only use of mechanisation for over burden removal is possible. But the final product of china clay cannot be easily minable by mechanical means. Thus, the basic problem encountered in these deposits is the high cost of initial mining

CHINA CLAY OCCURRENCES IN MAHESANA DISTRICT.



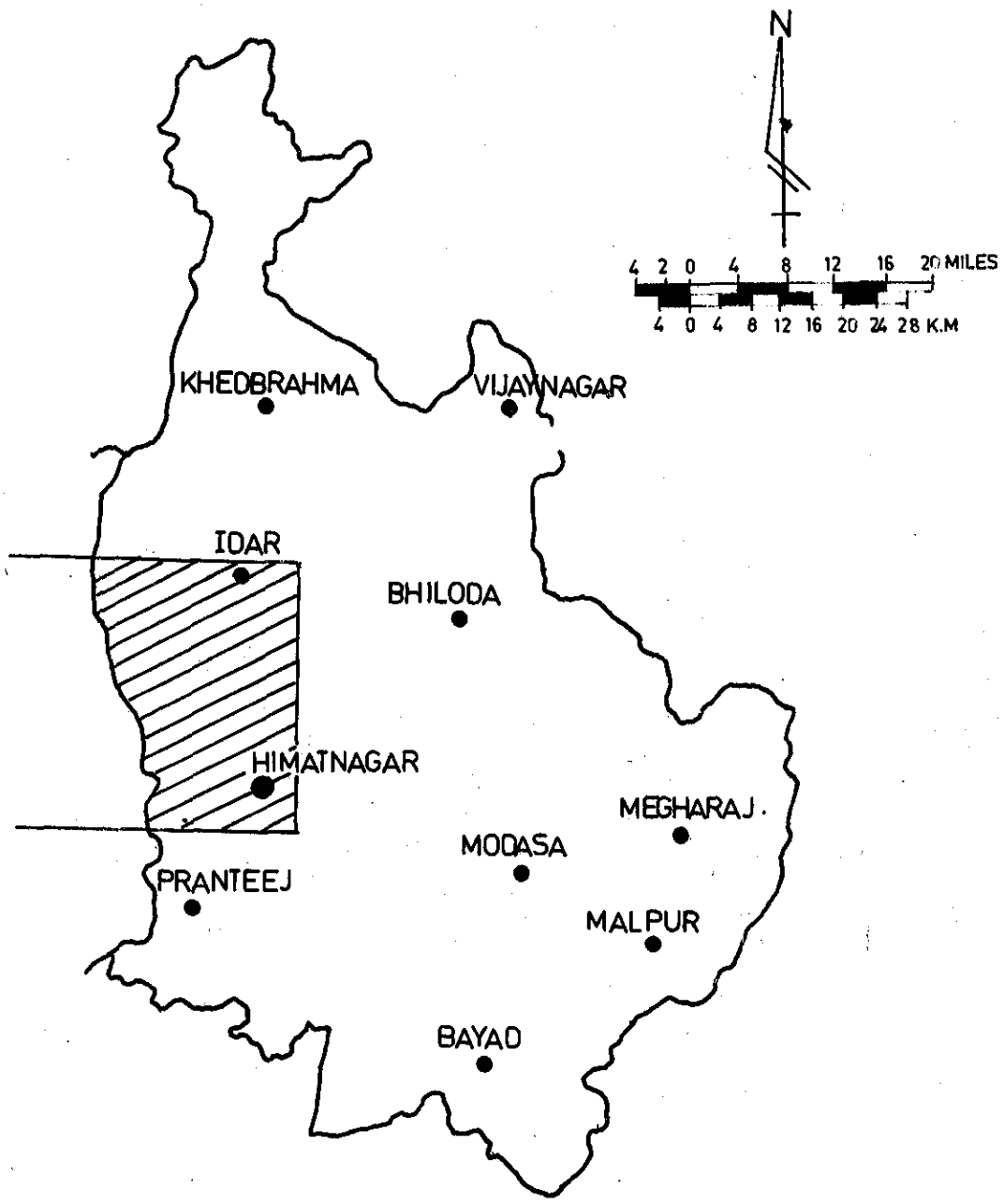
Sr. No.	Characteristics	Requirements Grade-I	Grade-II
i.	Finess(residue on 44 micron 15 sieve) percent by weight max.	1.0	2.0
ii.	Loss on ignition, percent by weight min.	12	10.5
iii.	Alumina(as Al_2O_3) percent by weight min.	36	30
iv.	Oxides of iron(as Fe_2O_3) percent by weight max.	1.0	1.5
v.	Titanium oxide(as TiO_2) percent by weight mmax.	0.7	1.5
vi.	Oxides of iron(as Fe_2O_3) and Titanium oxides(as TiO_2) percent by weight max.	1.5	2.75
vii.	Water of plasticity, percent min.	22	22
viii.	Shrinkages, lineark		
	a) Dry shrinkage(at 110 oC) percent max.	8	8
	b) Fired shrinkage(at Seger conc.12) percent max.	18	18

Rubber

Kaolin is used as a filler or an extender in both natural and synthetic rubber. Using 100 percent pure rubber in rubber products is expensive and so fillers and reinforcing agents are incorporated in the mix to improve certain physical properties as well as to lower the cost. Addition to kaolin tend to improve the tensile strength of rubber and its resistance to tear and abrasion. The principle manufacturers using large quantities of kaolin (hard varieties) make such products as footware, cable etc. Softer grades of kaolin do not have the reinforcing effect of the hard grades and are used to lower electricity and improve abrasion resistance. Products such as floor tiles and certain soft rubber goods make use of soft kaolin grades in their compounding.

There are a number of competing materials used as fillers and extenders in rubber. Barytes for example, being heavy is incorporated in rubber products, where high density is an important criteria. Calcium carbonate is a leading competitor and is comparable in cost. Precipitated silica and silicates are used extensively in the compounding of rubber and to impart the highest reinforcing characteristics of all the fillers discussed above. However, high cost prohibits their adoption in large quantities. Specification (IS: 505-1978) for industry is given below :

CHINA CLAY OCCURRENCES IN SABARKANTHA DISTRICT



Sr. No.	Characteristics	Textile & paper coating
1.	Residues on 55 micron 15 sieve	0.1% (max.)
2.	Particles larger than 10 micron in diameter	5.0% (max.)
3.	Particles smaller than 2 microns in diameter	62.0% (min.)
4.	Relative density at 27/27 ^{o}C	2.5-2.6
5.	Loss on drying	6.0% (max.)
6.	Matter soluble in HCL	2.5% (max.)
7.	Fe_2O_3	0.7% (max.)
8.	Colour reflectanse to blue light of wave length 3040 A.	80-85%

Plastics

As with rubber, kaolin is used as a filler and reinforcing agent in the manufacture of certain plastics. For example, manufacturers of polyvinyl chloride make use of it for this purpose, as it serves to augment and enhance some of the physical properties that make PVC harder wearing. In wire insulation made of PVC, heat treated kaolin imparts a high electrical resistivity which allows the use of this type of insulation in applications that had formerly required more expensive polymers. In glass reinforced polyesters kaolin products have helped to eliminate production problems in the manufacture of automobile body parts. In this application kaolin products give good flow characteristics to the glass fibre reinforcing media resulting in a stronger and more uniform part.

This is a big area of growth for kaolin. As far as other applications in plastics are concerned, kaolin has found only limited markets mainly because of poor dispersibility in systems. It is used to a reasonable extent in vinyl floor coverings but competes with talc in this field. Although kaolin is cheaper than talc in certain products use of talc is preferred as it promotes translucency in the finished products. Whereas, use of kaolin leads to capacity. Specifications (IS: 505-1978) for filler in paper is given below :

Sr. No.	Characteristics	Filler paper
1.	Residue on 53 micron 15 sieve	1.0% (max.)
2.	Particles larger than 10 microns in diameter	20.0% (max.)
3.	Particles smaller than 2 microns in diameter	35.0% (min.)
4.	Loss on drying	6.0% (max.)
5.	Loss on ignition	14.0% (max.)
6.	atter soluble in water	0.5% (max.)
7.	Matter soluble in HCL	2.5% (max.)
8.	Fe_2O_3	0.7% (max.)
9.	pH value of aquous extract	4.5 to 7.5

V
SPECIFICATIONS FOR VARIOUS CONSUMING INDUSTRY AND ITS USE

Kaolin finds many industrial applications and new ones are still being discovered. Its value lies in its chemical inertness, whiteness, hiding power as an extender, reinforcing characteristics, low conductivity of heat and electricity etc. User industries differ greatly in their specific requirements. Some require kaolin as a cheap filler i.e. relatively free from impurities and are not too fussy about colour. Others require grades of kaolin with exceptional brightnessor specific particles sizes for specialised applications. At the bottom of the scale are uses such as cement additives for which poor quality kaolin clays are suitable and therefore elaborate processing methods are not required. However, for the majority of uses, the modern tendency is to produce standardised products from a group of mines with a variety of instrumental controls to maintain the desired properties. The better grades of kaolin easily accounts for majority of kaolin sold both in terms of tonnage and of value. Indeed, such is their importance that the better grades are frequently designed for specific end-uses. Some of these uses e.g. paper, rubber, paint etc. are described in greater details as under :

Ceramic

Historically speaking kaolin was first used in ceramics and this is still possibly the best known application today despite the fact that it has long been overtaken by paper. In the United States, a number of products fall under the general heading of ceramics and are usually divided into the following categories such as structural clay products, including bricks, drain tiles, sewez pipes, glazed tiles, terracota, refractories, whiteware pottery or stoneware and porcelain. In the first category of structural clays, the type of clay used must have particular property under such headings as plasticity, green strength (which eases handling firing, shrinkage, vitrification range and fired colour). In fact, kaolin is just one type of clay used in the fabrication of these products and usually the kaolin used is not particularly pure or high grade.

Raw materials for the manufacture of refractories are again many. However, nearly all refractory clays are composed predominantly of kaolinite. This includes clay such as flint clay etc. which are dealt separately elsewhere. Relatively pure kaolin having PCE in the range of Orton Cone 33 and above are used for this purpose.

Whiteware is usually composed of feldspar, flint or quartz and a suitable clay. The most commonly used clays are kaolins and/or ball clays. Kaolin is better crystallised than ball clay and is consequently slightly more refractory. Both these clays confirm to the required properties as outlined for structural clays.

In stoneware making various clays are suitable. It is not necessary for the product to fire white and so kaolins are used due to non-availability of low fusing clays. The basic ingredients in porcelain are clay, feldspar and quartz. The clay must have adequate plasticity associated with finer particle sizes. A lot of porcelain goes into electricalware as insulators, wherein factors such as conductivity, dielectric constant, power factor, power loss and other parameters are important. High purity kaolin and ball clays excel in this field. Specification (IS:2840-1985) for ceramic industry is given below :

Sr. No.	Characteristics	Rubber
1.	Residue on 53 micron 15 sieve	1.0% (max.)
2.	Particles larger than 10 microns in diameter	7.0% (max.)
3.	Particles smaller than 2 microns in diameter	50.3% (min.)
4.	Loss on drying	2.0% (max.)
5.	Loss on ignition	14% (max.)
6.	Matter soluble in water	0.5% (max.)
7.	Matter soluble in HCL	2.5% (max.)
8.	CuO	0.09% (max.)
9.	Fe_2O_3	0.7% (max.)
10.	MnO	0.013% (max.)
11.	Oil absorption	50 ml per 100 gm (min.)

Paper

In paper, kaolin is used as a filler and for coating. As a fillter, it is used to fill the interstices of the paper fibres. This gives improved opacity and colour and imparts a smoother surface to the finished paper, thus, improving its affinity for printing ink. Also, kaolin is less expensive than paper pulp and therefore, effectively lowers paper production costs. It is inert to other ingredients in the paper and is retained well between fibres and is available cheaply in large quantities. As a coating material kaolin has all the above properties plus other advantages such as high gloss, brightness and low viscosity at high solids content. The later is important, since at today's fast paper production rates the coatings must be applied at high solid contents to impart the correct thickness and opacity to the paper all in a very short space of time. Kaolin flows well under these critical condition and still manages to give the paper a smooth and even film. Its platy structure elands itself particularly to the production of high gloss papers. Aluminum hydroxide or hydride has replaced china clay in those fields owing to its extra whiteness and gloss. Magazines such as 'Life' in the US can contain upto 20% by weight of kaolin. In an untreated form, kaolin is not particularly bright but by using chemical beneficiation means such as bleaching, grades of coating clays with brightness exceeding 90% are now common. Air floated grades are not certainly used for coating paper, and all coating grades of kaolin are water washed. Some heat treated kaolin may be used for filling paper where abrasion resistance is required.

Kaolin meets with comparatively little competition in the paper industry because of its low cost and good performance. Precipitated calcium carbonate is the main competitor and is used by paper manufacturers in conjunction with kaolin for coating purpose. It tends to have a higher brightness than kaolin used alone and also responds better to ink application. Specifications (IS: 505-1978) for paper coating & textiles is given below :

Cosmetic & Pharmaceuticals

There is no ISI specification. Superfine china clay is utilised for the manufacture of products like powder, adhesives, surgical plaster lotion and ointment for external use, porcelain for dental preparation. China clay for medical purposes must be free from lead, arsenic and other metal which the human body will not tolerate. It should have no frothing. Particle size, frothing and sedimentation values are the three important factors, considered in the selection of china clay for pharmaceutical purposes.

There are also fairly specialised uses such as in pharmaceuticals, where highly refined kaolin serves as a vehicle for many preparations, such as stomach powders and tablets. In another process kaolin can be converted into highly selective molecular sieve zeolites. These can be used as efficient catalysts in improving the yield of petroleum from given grades of crude oil.

Paint

In the paint industry, kaolin is used because of its whiteness and its opacifying effect attainable at a relatively low cost. As a filler or extender, it cuts down the amount of expensive pigment required to formulate a paint. To qualify as a filler, the kaolin must be easily dispersed in the mix; have a good colour, possess antisettling powers and have good rheological properties as well as fine particle size. It is mostly used in interior, flat, wall paints and in metal industrial primers. Washed grades of kaolin wet easily in water and are therefore, particularly suited to latex paints. Because of its plate like structure, kaolin helps the paint to move easily over surface and contributes to hiding power. Its use in exterior paints is limited, since it tends not to have the durable qualities of talc and calcium carbonate, which are its major competitors. Calcined or heat treated grades of kaolin because of their resistance to abrasion and their dry hiding power, are being increasingly used by paint manufacturers. They are also much suited to latex systems, which facilitate the formulation of paint products.

China clay is used as an extender or suspending agent in the manufacture of white paint. The ISI has not standardised any specification for this use. However, the properties like anti setting and tinting aqffect, collidal nature, softness, freedom from grit, white colour and fine size are some of the qualities which make china clay suitable for use in paint and distemper manufacture.

Other Uses

These are the main applications of kaolin. In its filling capacity kaolin has a number of other important applications which need to be mentioned. Although in terms of tonnage the markets are relatively small, kaolin is used widely as a filler in the fabrication of certain adhesives and in textile coatings and backings. In the adhesive groups, air floated kaolin is used in limited quantities in cheap adhesive cements made of reclaimed rubber, where it lowers cost and improve workability. It is also used in low cost adhesives for floor tiles based on asphalt. Some adhesives are filled with water washed kaolin, particularly those made out of starch, dextrine, etc. which are used for bonding paper. In textile coating, water washed kaolin serves essentially the same function as in paper coating and in carpet backing kaolin is used in formulations made from natural rubber latex. Another market similar to paint is printing inks, but this is a relatively small outlet.

Among slightly more general purpose applications but not less importance are uses of kaolins in fertilizers where it is used as an caking agent or as a conditioner and in insecticides as a carrier.

Insecticides

China clay is used in the manufacture of disinfectant like DDT. The ISI (IS: 505-1978) has standardised the specifications for use of china clay in insecticide industry as given below :

Sr. No.	Characteristics	Insecticide
1.	Residue on 53 micron 15 sieve	2.0% (max.)
2.	Particles larger than 10 microns in diameter	20.0% (max.)
3.	Particles smaller than 2 microns in diameter	35.0% (min.)
4.	Loss on drying	6.0% (max.)
5.	Loss on ignition	14.0% (max.)
6.	Matter soluble in water	0.5% (max.)
7.	Matter soluble in HCL	2.5% (max.)
8.	Al_2O_3	10 ppm (max.)
9.	Fe_2O_3	0.7% (max.)

f) *Sheet Properties*

Sheets of paper can be coated with kaolin and a binder following standard procedures outlined by the Technical Association of the Pulp and paper Industry. In order to evaluate the application of a particular clay for coating purposes, the coated sheet must be conditioned, calendared, dried and many properties determined.

g) *Opacity*

This is influenced by particle packing and is largely dependent on size and shape of the particle distribution. The presence of ultrafine particles in the range of 0.1 um and less reduces the opacity and the optimum opacity or covering power of coating clay is developed by the presence of particle in the size range 0.3 - 1.5 um.

h) *Gloss and Smoothness*

The presence of fine particles imporves the gloss on the coated paper. Gloss is commonly related to high pore volume which reinforces the specular reflectance. Gloss is affected by the presence of ultrafine particles. Smoothness is not dependent on optical phenomena. However, fine, thin and small diameter particles are necessary for the ultimate development of smoothness.

i) *Film Strength*

This is related to preferential adhesive migration into the substrate and to the preferred orientation of the kaolin particles; a well dispersed coating clay of fine particle size with low relative sediment volume will give the highest film strength.

j) *Ink receptivity*

This coating property differs for different grades of clays. Small diameter particles randomly oriented give excellent ink receptivity. The presence of small quantities of "smectite" promotes ink receptivity but inhibits ink holdout due to its high surface area and strong sorptive. In general, as the clay particle size decreases ink holdout increases.

k) *Adhesive demand*

Adhesives, such as strach or latex, bind the clay particles together and to the sheet of paper. Adhesive requirement is directly related to the surface area of the clay and must be carefully controlled since it also influences opacity, brightness, colour and smoothness.

As mined kaolin is a soft, friable mass which must be reduced to a fine particle-size before use. The crude clay may be crushed, or it may be dispersed in water to turn it into a slurry. Crushed kaolin is ground further and classified by air-floating. This is the first majaor classification into grade according to the degree of processing. The product is known as 'Air-floated' grade and usually commands lower prices than the next category 'water-washed' kaolin produced essentially by washing and bleaching slurry kaolin and then classifying it by various hydraulic methods. There is a final category which in terms of tonnage is possibly the smallest of the three. Some produces calcined kaolin. When water washed kaolin is heated at temperatures of $1000^{o}C$ and more for a long period, it undergoes a change and converts to mullite, cristobalite and/or silica alumina spinel. In this form, it has a brighter appearance and is much more abrasive. Because of different physical and chemical properties, it usually finds applications in areas unrelated to the other two categories, although there is some overlapping.

There are two basic methods of processing kaolin, a dry method or a wet process (Guillet and Kriens, 1984). The dry method is called air flotation which separates the clay from contaminants.

VI
PROCESSING TECHNOLOGY

PHYSICAL & CHEMICAL PROPERTIES :

The physical properties of kaolins are very important with respect to their suitability for different applications and several authors have reviewed these relationships. The following are some of the important properties which should be determined in order to evaluate kaolin for different applications.

a) *Particle size determination*

The shape and size distribution of kaolin are iportant factors in controlling many other properties like brightness, viscosity, opacity, gloss, ceraic strength and shrinkage. These also affect the paper filling and paper coating properties such as the mechanical, optical and printing characteristics of a finished sheet of paper. The particle size is expresses as e.s.d. (equivalent spherical diameter) and is determined by sedimentation methods from a deflocculated suspension of clay in water.

b) *Brightness and Whiteness*

The absorption coefficient of a kaolin can be modified by chemical treatemnt or by beneficiation to remove colored impurities. The standard brightness values of kaolins are determined by measuring the diffuse reflectance of light of a particular wavelength generally 457 nm and is compared to a subsidiary standard which has been calibrated in a laboratory approved by the International Standards Organization. The presence of ancillary minerals such as micas, tourmaline and titaniferous impurities contribute substantially to the light absorption as do hydrated iron oxide coatings on the kaolinite particles.

c) *Rheology*

Measureents of the viscosity of clay-water slurries are made at precise solids concentrations, norally 67% for delaminated clays and either 70 or 17% solids for ultrafine size clays.

The surface area of the clay controls the low shear viscosity at a given solids level. The coarse clays generally have lower Brookfield viscosities than fine clays. High shear rheology is more dependent on the particle shape. Most regular coating clays are controlled in the range of 300 cp or less at 20 rp. At high shear rates as measured on a Hercules Viscometer, coating clays might range fromm 18 dynes c x 10 at 700 rpm bob speed to 3 or 4 dynes c x 10 at 1100 rpm bob speed.

d) *pH*

The pH of coating clays range from 6.5 to 7.5. A high pH generally indicates the presence of soluble salts which can cause severe probles in many applications.

e) *Screen residue*

Screen residue indicates the presence of coarse particles that are retained on a 325 mesh screen. Quartz, ic and feldspar along with agglomerates of tightly bonded clay and the most common minerals are retained on the screen. This is an important property to be determined in both dry and wet processing of clay.

Paper manufacturers are by far the largest users of water washed kaolin. Over the years there has been a trend towards lighter and glossier paper which demands coating clays conforming to much more rigorous specifications. Consequently, the traditional methods of processing such as centrifuging have proved no longer adequate.

i. *Fractionation*

Kaolin slurries resulting from the primary processing at the mine are generally too coarse in size and it is therefore necessary to fractionalize. Fractionation include settling tanks, hydroseparators, hydrocyclones or decanting centrifuges. Settling tanks and hydroseparators have been replaced by more efficient hydrocyclones or decanting centrifuges.

ii. *Bleaching*

Following fractionation, the kaolin may not have the brightness required for paper coating. Clays are often discolored by the presence of ancillary minerals such as mica, tourmaline and titaniferrous impurities, or by coatings of hydrated iron oxides. Various methods of chemical bleaching to improve the brightness have been reported. Oxidative treatments involving the use of ozone (Allegrini et al., 1970) hydrogen peroxide, potassiumm permanganate and sodium hypochlorite are used to remove the absorbed layers of carbon to improve the brightness. The presence of hydrated iron oxides or oxyhydroxides that coat the kaolin particles may be either oxidized or reduced. The pink and yellow tinted kaolins are treated by lowering the pH to 3 with sulfuric acid which solubilizes the iron.

A strong reducing agent, sodium hydrosulfite, is added which reduces the iron and keeps it in a soluble ferrous state which is removed during the dewatering/filtration step.

iii. *Magnetic separation*

The process of magnetic separation is based on the differences among the magnetic susceptibilities of various mineral species. The colored impurities in the kaolin clay, e.g. anatase, rutile, hematite, mica and pyrite are freebly agnetic with sesceptabilities.

Magnetic separation has proven particularly successful with grades of kaolin that otherwise do not respond to conventional bleaching techniques. The development was a very significant process breakthrough in that it dramatically increased the reserves of kaolin in Georgia. Anajor breakthrough in HGMS technology has recently been made with the first industrial application of superconducting HGMS.

iv. *Froth Flotation*

Froth flotation has been applied to process kaolins both from primary and secondary deposits. The application of flotation to th processing of primary kaolins was reported.

In the flotation process, the kaolinite and mica particles are separated and the resulting concentrates are suitable starting material for several commercial grades. The removal of "free" silica from kaolin by the application of direct cationic flotation was attepted on innesota clays at an acid pH of 2.5. The results indicate that essentially complete removal of "free" silica fro a flotation feed of minus 65 mesh size containing 49% free silica was obtained using amine acetate as a collector.

Application of flotation for secondary deposits is centered mainly on reoving the titaniferous impurities which affect the brightness of the final product. The presence of titanius impurities

the wet method produces water washed clay where the clays are fractionated, beneficiated or otherwise modified fro their original state. When used in the paper industry, air floated clays are used exclusively as filler pigments while water washed clays are used as both fillers and as coating pigents.

The primary step in processing kaolin is to separate the abrasive minerals like quartz and undesirable minerals such as mica. This process is similar in the case of secondary deposits which have undergone natural classification during transportation. By contrast, the separation of kaolin from primary deposits is more difficult due to the presence of a high proportion of abrasive minerals that have survived the alteration process.

DRY PROCESS

The dry processing of kaolin is relatively simple, has lower costs, lower yields and lower quality products than the wet process. The essential feature of the dry process is to dry the crude clay so that it can be pulverized. The crude clay, as it enters the storage shed, is shredded or crushed to relatively small pieces. The crude at this stage contains 20-25% moisture which is removed in a rotary drier. After drying, the kaolin is pulverized in a roller mill and is fed into the grinding section of the mill where plows lift the clay into the area where the rollers grind it against the grinding ring. The disintegrated kaolin may then be air classified whereby the finely ground product is lifted through the top of the machine to the outlet duct.

Air Floated Grades

The dry kaolin can be separated into various ranges of particle size, and by blending different grades of crude its brightness can also be adjusted. In the same way, physical properties can be altered to suit certain appalications. As a result, numerous grades are commercially available. Because, the rubber industry is the largest user of air-floated kaolin, those grades have traditionally been classified undr one or two headings depending to their effect in the rubber compounding process. A grade is 'hard' if it reinforces rubber and 'soft', if it does not. Hardening and softening effect on rubber depends on a large extent on particle size. A finer particle will make the rubber hard, and a coarser particle will leave it soft. Although emphasis is placed on brightness, it is not so critical as in water washed grades. Consumers tend to place greater importance on the consistency and uniformity of grades.

WET PROCESS

The wet processing of kaolin is more complex than the dry process technique. The first step is simply to make the crude clay into a slurry. In order to separate kaoline from the mineral impurities such as quartz and mica and to be fractionated into fine, mediu and coarse grades, the slurry must consist of indivudual mineral particles separated from each other and suspended in water.

With the vast application of techniques now available for chemically treating and separating kaolin into finer and brighter grades, and with also a variety of blending process, it is theoretically possible to produce an almost infinite range of water washed kaolin grades. Despite newer developments in refining techniques the processing of kaolin clays still follows several fairly well defined steps. It starts with blunging, which is the initial disintegration of the crude clay lumps into their natural particle sizes. The presence of a de-fluctuating agent causes the suspension to change from a plastic condition into a watery state, in which it is pumped to the refining plant. Processing first involves a degritting procedure to remove major contaminations. Then centrifugal size classification into closely controlled frctions is performed. After this, the clay is 'bleached' to remove the colouring caused by iron compounds and then thickened before being filtered on large rotary vacuum drums or filter presses. It is then returned to the fluid state.

are usually in the form of ultrafineparticles less than 2 microns in diameter which are present in small amounts and are difficult to remove with direct flotation.

v. *Selective flocculation and coagulation*

When a clay slip is overdispersed with excess of sodium hexametaphosphate and the suspension is left undisturbed, some of the titaniferrous impurities coagulate and settle out preferentially. This methods was applied commercially for some time before being replaced by selective flocculation.

Kaolinite is flocculated with a high molecular weight and strongly anionic polymer while leaving the titanium and iron contaminants in the suspension. Although the application of selective coagulation and flocculation processes have been proved to be highly successful for the separation of titaniferous impurities from East Georgia clays, they do have some limitations: these include the use of low pulp density, low kaolin recoveries due to the entrapment of the clay in the settled flocks and the deleteious effect of the polymer on the final product.

vi. *Delaination*

The process involves the high shear agitation of a koalin slurry with pellets or beads at optimum pulp density. To achieve effective delamination, it is necessary to remove the bulk of less than two micron particles contained in the feed slurry and the coarse fraction is delaminated in the attrition mills with fine glass beads or plastic pellets as media. The brightness and whiteness of the delaminated koalin are improved along with certain coating properties.

vii. *Calcination*

Calcination is a process to produce special grade kaolin products. Two different grades of calcined kaolins are produced depending on the treatment temperature. Calcination at teperatures in the range 650-700^{o}C removes the structural hudroxyl groups and the escaping water vapor produces a bulky product with enhanced resiliency and opacity which are desirable sttributes for paper coating applications.

viii. *Surface treatment*

Kaolin surfaces are chemically modified to produce hydrophobic and organophillic characteristics. Generally, an ionic or a polar nonionic surfactant is used as a surface treating agent. Many manufacturers develop their own methods and the demand for speciality clays continue grow rapidly throughout the world.

VII
HIGH-TECH CHINACLAY BENEFICIATION

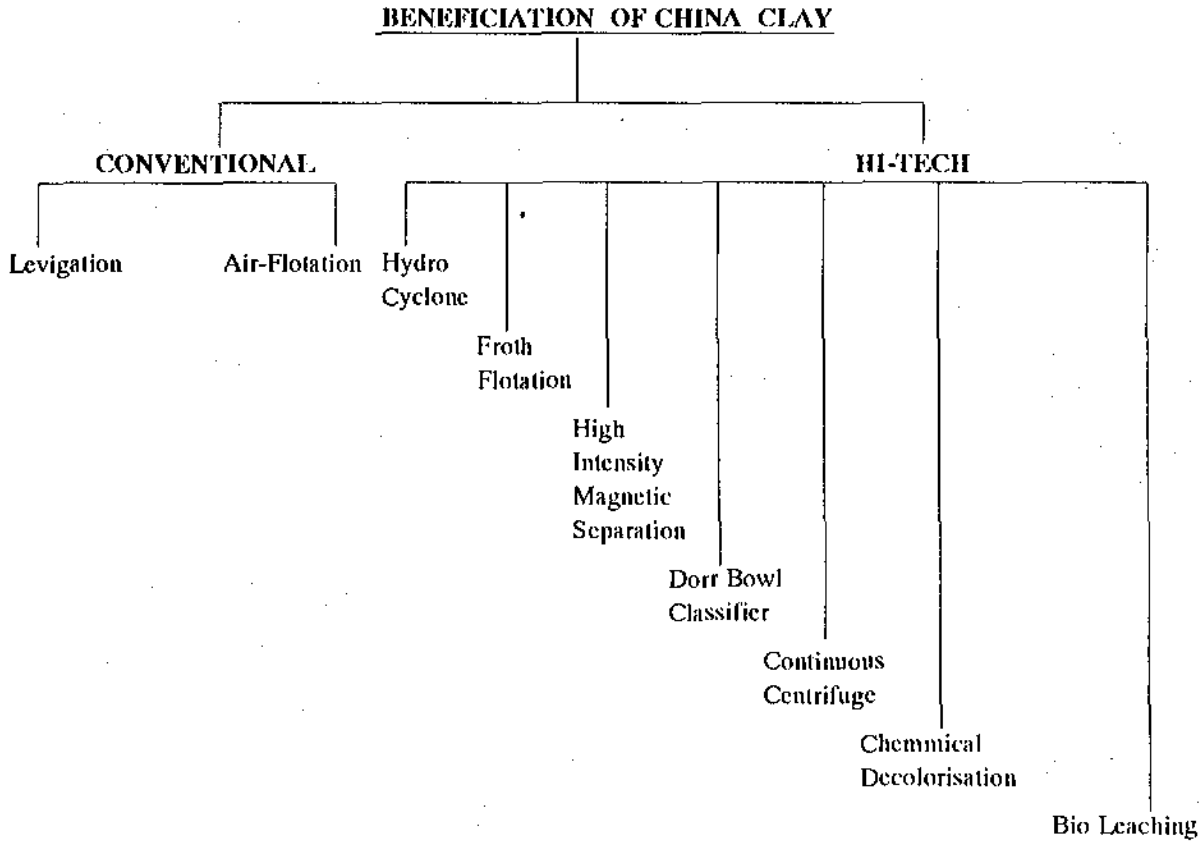
Conventional levigation by sedimentation is carried out by different units in the State. Plant operators in Kachchh, Mehsana & Sabarkantha districts are able to process 1000 tonnes refined clay for ceramic applications, fillers and rubber.

China clay originated from granite, sandstone and pyroclasts has different impurities like TiO_2, SiO_2, CaO, Fe_2O_3. Particle size and whiteness are not controlled. China clay used for textile, rubber, paper, pharmaceuticals and cables have different specifications. To meet these requirements, impurities have to be removed by adopting process know-how evolved by different R&D organisations and laboratories. I.B.M.-Nagpur, R.R.L.-Bhubaneshwar, R.R.L.-Trivandrum have done extensive laboratory works. On the basis of above laboratory results and flow chart, china clay lease-holders or entrepreneurs can think to plan china clay benefication projects adopting suggested flow sheet with indicated equipments.

iNDEXTb has signed MOU with Indian Bureau of Mines, Ore-dressing Laboratory, Nagpur for "Techno-feasibility of china clay and other minerals". The report will be available on a charge basis to interested entrepreneurs.

In Gujarat, seventy two china clay lease holders covering 1,01,930 hectares area exploits 19,000 tonnes china clay per annum. Conventional plant has very poor recovery. To adopt modern benefication techniques by Aircyclone or by Hydrocyclone, benefication results have shown that whiteness can be enhanced by bleaching and floculation.

Desirous entrepreneurs interested to establish the benefication plant can locate in Himatnagar, Mehsana, Bhuj, Bhachau places in Sabarkantha and Kachchh districts.



Beneficiation of Chinaclay

(1) **Conventional/Traditional approach** — (a) Dry process of air-floatation; (b) Wet process of washing

(a) *Dry Process of air-floatation*

1. Pulverising the dry crude clay
2. Separation of excessive coarse impurities
3. Lifting of the particle of desirable fineness from the grinding chamber by air currents.
4. Rejecting the coarse particles from the upward stream by whizzer type separators.

Equipments required in dry processing of china clay are mostly air-floatation plants consisting of

i) Rotary type dryer

ii) Raymond-roller mill with whizzer separators

iii) A cyclone collector

iv) A bim

v) A conveyor

The suitability of the application of the dry processing technique is pre-determined mostly by the inherent brightness, frit content of the clay and ultimate end use of the clay.

(b) *Wet Process*

1. Disintegration of crude clay lumps
2. Slaking in water and blunging with electrolyte to act as a deflocculant to separate clay materials from non-clayey materials.
3. Separation of definite particle size ranges by fractionation and sedimentation technique.
4. Filtration of the clay frctions in a filter press.
5. Drying of the filter pressed clay.

(2) **Hi-Tech Approach**

i) Hydrocyclone separator

ii) High intensity magnetic separator

iii) Ultrafine selective froth floatation

iv) Dorr Bowl classifier

v) Continuous centrifuge

vi) Chemical decolourisation

vii) Bio-leaching

i. *Hydrocyclone separator*

Hydrocyclone or hydroseparators are equipped with devices which permit a continuous overflow of the recovered fraction, synchronised with the proportionate withdrawal of the settled layer. This is a high-tech approach to fractionate different sizes of the clay by adopting a desired aparture size of the hydrocyclone battery. This a more scientific approach and has advantages over sedimentation technique usually followed in conventional levigation plants/units of clay washery. The different size fractions as required by different industries could be sorted out and supplied. For instance, paper, textile and rubber industries require finer frctions (1 um) whereas ceramic industry would prefer fractions above 1 um. This is an all weather plant and could be operated through out the year, since it is housed under a shed.

ii. *High intensity magnetic separator*

This is another high-tech approach for beneficiation of kaolin clays. This can be done in two ways :

1. Dry magnetic separator - usually followed to remove iron bearing particles from easy-flowing materials like quartz, etc. This is not within the scope of this presentation.
2. Wet magnetic separator.

Now by applying this process magnetic, paramagnetic and feebly magnetic particles can be removed from clay slurry. Successful implementation of the process to remove a particular colour bearing mineral from kaolin clays is very much dependent on the magnetic field strenfgth and the duration for which the clay slurry is kept in that field. Next figure shows the magnetic field strength require to remove a particular mineral from kaolin slurry.

iii. *Ultrafine Selective froth floatation*

This is another high-tech approach to beneficiate clay minerals by removal of non-clayey minerals like rutiles, etc. The process involves the folowing steps :

1. Conditioning of the fractionated portion of kaolin clay with ammonium sulphate, coarser marble and sufficient water to provide a total solid of 22% in the subsequent conditioning.
2. Ammonia was added to the conditioned pulp to attain a pH 9.0.
3. Light hydrocarbon oil is added.
4. Conditioned pulp was transferred to Denver's Floatation Cell.
5. Titania is removed with the froth. By applying this process more than 50% anatase could be removed from kaolin clays.

iv. *Dorr Bowl Classifier*

The classifier widely used in America, consists of two main parts (a) the bowl, and (b) the washing compartment. The clay slip is fed into the bowl centrally; there, settling of the sand occurs most effectively and purified grit-free slip slowly overflows as a thin film over a strip which extends completely around the circumference of the bowl. The sand deposited at the bottom of the bowl is moved towards the centre by plough blades attached to a set of slowly revolving arms. It, then passes through the washing compartment against a counter stream of clear water which removes the adhering clay. The process is completed in the washing compartment where the sand is raked through a spray of water. Dorr bowl classifier therefore, produces not only sand-free clay but also clay-free sand and hence no clay is wasted.

v. *Continuous centrifuge*

Time, space and labour can be saved by accelerating sedimentation by continuous centrifuging technique. The bird continuous centrifuge consists essentially of a conical rotating vessel fited internally with a screw conbeyer rotating at a slightly different speed. The slurry to be separated into fine and coarse grained portions, is fed in centrally. The coarser fractions are thrown to the wall of the vessel, while the fine suspension discharges at the vider end. The machine is capable of washing about 100 tons of material per hour.

vi. *Chemical Decolourisation*

This high-tech approach is most effective for marginal improvement in brightness of kaolin clays to make them suitable for paper and textile industry by way of removal of iron bearing particles which have escaped the earlier stages of beneficiations. The process (covered by Indian Patent No.87428-1963) involves the following steps :

1. Treatmment of the clay slurry (10-15% solid) with suitable chemicals to make soluble salts of iron.
2. Washing of the treated clay to remove excess chemicals.
3. Filter pressing and drying of the beneficiated clay slurry

   Or

   Spray drying of the clay slurry.

vii. *Bio-leaching*

This is reported to be most modern technique to remove the trace impurities from kaolin clays. The clay slurry is treated with special type of organic enzymes suitable to react with a particular mineral like quartz, anatase, iron, etc. to form a complex and then removed from the clay slurry by washing and filtration.

Conclusion

Beneficiation approaches to be followed are very much dependent on the end use of the clay.

A combination of all or majority of the high-tech process will give a better and consistent quality of kaolin clays and would be a value added product.

PROJECT PROFILES

CALCINED CHINACLAY

INTRODUCTION

Kaolin is one of the most versatile industrial minerals. It is chemically inert over a relatively wide pH range, is white in colour and has good covering power, when used as a pigment or extender. Kaolin is soft and non-abrasive and has a low conductivity of heat and electricity. Some uses of plastics require very rigid specifications including particle size, colour and brightness and viscosity whereas other uses require no specifications, for example in cement where the chemical composition is most important. The paper industry conssumes the largest amount of kaolin where it is used both as a filler and as a coating material on the paper surface to improve the quality of printing. Special grade kaolin is produced by heat treatment.

MARKET POTENTIAL

China clay is mostly consumed in crokery, ceramic tiles, rubber, sanitaryware, insulators and paper industries. Some heat treated kaolin may be used for filling paper. Kaolin is used as coating clay. It imparts a smoother surface to the finished paper, improving its affinity for printing ink. Kaolin flows well under critical condition and manages to give a smooth and even film. Its platy structure lends itself particularly to the production of high class paper. Calcined chinaclay have find application in cables, plastics, special rubber for specific properties.

	Application items	**Specific Properties**
1.	PVC cables	- Improve electrical properties
	High voltage compounds	
2.	Low and medium voltage	- Low moisture content
	power cable insulation	- Low water absorption
3.	Mechanical Rubber Goods	- Good processability
		- Low mill sticking
		- Neutral PH
		- Uniform cure rates
4.	Elastomers	- Good resilience
		- Low permanent set
		- Good electrical properties
5.	PVC	- Improve extrusion and calendering
6.	Polyamide	- Improve heat disortion and reinforcing properties
7.	Other Plastic/Rubber Applications	- Finest partical size
		- Significant increase in impact strength
		- Improvement in tensile & flexural modules

Fifteen levigation plants produces 1000 tonnes refined clay. Thirty four lease holders covering 72 hectares of land exploit an average 20,000 tonnes per annum crude chinaclay. Calcined chinaclay, due to specific properties, have good demands in cables, rubber, polyamide, plastic. No calcination of chinaclay unit exist in the State. Recently, M/s 20 Micron at Waghodia in Baroda has started

production of calcined chinaclay. Looking to the demand of cables, plastic units in the western India, demand for the product exist. The international price of calcined chinaclay range between $405-465. Paint, cables industries import from UK & USA.

CALCINATION PROCESS

There are two basic methods of processing kaolin, a dry method or a wet process. The dry method is called air flotation which separates the clay from contaminants.

Calcination is a process to produce special grade products. Two different grades of calcined kaolins are produced depending on the treatment temperate calcination at temperature in range 650-700°C removes the structural hydroxyl groups and the escaping water vapour produces a bulky product with enhanced resiliency and opacity which are desirable attributes for paper coating applications.

Kaolin undergoes structural molecular changes when calcined. These changes occur in four distinct phases :

Absorbed water is removed in the first stage. This stage is complete at 150°C.

The second stage, the hydroxylation change sees a structural change from kaolin to metakaolinite and the evolution of water. The reaction is endothermic, starting at 550°C - 650°C and is completed by 700° - 800°C. This metakaolinite formed at this stage is readiiy identifiable by X-ray analysis.

$Al_2O_3\ 2SiO_2\ 2H_2O$ ----- $Al_2O_3\ 2SiO\ 2H_2O$ (14% theoretically)

Kaolinite 500°C Metakaolinite

The third stage which involves the formation of a direct spinel followed by onset of mullite formation which causes the peak on differential thermal analysis at 1000°C - 1100°C.

$Al_2O_3\ 2SiO_2$ ----- $Al_2O_3\ 1.5SiO_2\ 0.5\ SiO_2$

925oC Silicon spinel

$Al_2O_3\ 1.5SiO_2$ ----- $Al_2O_3\ SiO_3$ + 0.5 SiO_2

1100°C 1:1 mullite

The fourth and final stage above 1100oC sees the final transformation to mullite and the latter being either amorphous or crystalline silica (crystaobolite).

$Al_2O_3\ SiO_2$ ----- $Al_2O_3\ 0.66SiO_2$ + 0.33 SiO_2

1400°C 3:2 mullite

PLANT & MACHINERY

Sl.No.	Particulars	Qty.(Nos.)	Price(Rs.)
1.	Blunger (3.04 mtrs.dia)	1	25,000
2.	Agitator (5.22/3.48 mtrs.)	3	60,000
3.	Drier	1	20,00,000
4.	Rotary Kiln	1	25,00,000
5.	Packing Machines		3,00,000
6.	Oil tanks & pipelines etc.		15,000
		Total	49,00,000

PROJECT SIZE

The project envisages to manufacture 15,000 tonnes per annum calcined china clay.

	(Rs. in lakhs)
Land	80.00
Building	75.00
Plant & Equipment	490.00
Working Capital	150.00
Total Cost :	795.00

RAW MATERIALS

Raw Chinaclay is exploited in Mamuara, Manfera, Bhachau, Goniasar villages in Kachchh district. Dhokawada of Santalpura taluka of Banaskantha district, Arasodia, Eklera of Sabarkantha district. At present, 500 tonnes washed clay per day is available from existing plant owners. Raw & refined china-clay @ Rs.400 to Rs.500 and @ Rs.1200 to Rs.1500 can be procured. Captive mines can be procured in Kachchh, Banaskantha and Sabarkantha districts by acquiring mining lease as per Mineral Concession Rules, 1989.

QUALITY AND SPECIFICATIONS

Calcined Chinaclay are used in PVC cables, mechanical rubber goods, elastomers, PVC, polyamide, plastic & rubber applications for specific properties.

All coating grades of kaolin are water washed. Some heat treated kaolin may be used for filling paper where abrasion resistance is required. Paper coating requirement as per B.I.S.(505-1978) is as follows :

i) Residue on 53-0.1 (Max. micron IS sieve)

ii) Particles Larger 5.0 (Max.) than 10 micro in diameter

iii) Particles smaller 62.0 than 2 microns in max. diameter

iv) Relative -2.5 -2.9 density at 27/27° Ca

v) Loss on drying 6.0 (Max.)

vi) Loss on ignition - 14.0 (Max.)

vii) Matter soluble in HC1-2.5 (Max.)

CaO :Al_2O_3-0.7 (Max.) : Colour reflectance to 80.85 : Blue light wave length 3040 A^o

Physico-chemical Characteristics of coating clay

Grade		China clay 20	China clay 10	Chinaclay CL100	Chinaclay CL500	Chinaclay CLT100	Chinaclay CLT500
Type		Lavigated Air-floated Mirco-nised	Lavigated Air-floated Mirco-nised	Calcined Mirco-nised	Calcined Mirco-nised	Calcined Mirco-nised coated	Calcined Mirco-nised coated
Particle Size Distri-bution	Average M	3	1.5	2	1	2	1
	Topcut M	20	10	10	6	10	6
	Surface area M^2/Gm	7.8	15.5	11.4	22.8	11.4	22.4
Physical Analysis	Sp. Gravity	2.58	2.58	2.63	2.63	2.63	2.63
	Bulk Density (Gm/Litre)	680	550	600	520	610	530
	Dry Brightness	86	86	88-90	88-90	88-90	88-90
	Oil Absorption	42	55	65	72	46	52
	PH(Sat.Soln.)	8.0	8.0	7.5	7.5	N.A	N.A
	Moisture	0.5 (Max.)	0.5 (Max.)	0.2 (Max.)	0.2 (Max.)	0.05 (Max.)	0.05 (Max.)
Chemical Analysis	SiO_2	44.5	44.5	51.3	51.3	51.3	51.3
	Al_2O_3	36.1	36.1	44.2	44.2	44.2	44.2
	Mix Oxide	4.5	4.5	2.7	2.7	2.7	2.7
	Loss on Ignition	14.6	14.6	1.3	1.3	1.3	1.3

Source: 20 Microns Ltd, 307-308 Arundeep Complex, 3rd Floor, Race Course(S), Baroda-390 015.

NAMES AND ADDRESSES OF KILN MANUFACTURERS

1. Andrew Hule & Co. Ltd
(A Govt. of India Enterprises)
Yule House, 8 Clive Row
Calcutta-700 001

2. Bird & Co (Pvt) Ltd
Chartered Bank Building
Calcutta-700 001

3. Larsen & Toubro Ltd
L&T House, Ballard Estate,
PO Box.278, Bombay-400 038

4. Testeels Limited
Navdeep Building
Ashram Road, PB No.5, Navjivan
Ahmedabad-380 014

5. Vulcan Engineers Pvt Ltd
Mahalaxmi Chambers
Bhulabhai Desai Road,Bombay-400 026

NAMES & ADDRESSES OF RAW MATERIAL SUPPLIERS

1. Eklera Chinaclay Works
8 Janpath Commercial Centre
4th Floor, Opp Capital Comm. Centre
Ashram Road, Ahmedabad-380 009
Phone: 443343

2. Amrapali & Co.
289 New Cloth Market
O/s Raipur Gate
Ahmedabad-380 002
Phone: 361253/365851, Fax: 313175

3. Shri HD Patel
HD Enterprises Pvt Ltd
HD House, Silver Point, New Station Road
PO Bhuj-370 001, Dist. Kachchh
Phone: (02832) 21972, Fax: (02832) 21937

PAPER COATING CLAY

INTRODUTION

Gujarat has potential of 65.3 million tonnes of China Clay contributing share of about 9.2% and ranking fifth in the field of production. Districts of Sabarkantha, Mehsana and Kachchh are richly endowed with good quality of China Clay. The total reserves in Sabarkantha, Mehsana districts are 62 million tonnes and 2 million tonnes respectively. The production of processed clay is 6700 metric tonnes in the State. Potential locations for benefication with modern techniques should be in Sabarkantha district. The adopted methods of mining and benefication of China clay are primitive, as compared to the techniques adopted in England, Czechoslovakia and USA. The methods that may render our clays a considerable improvement in quality and bring down the cost of production are hydrocyclone beneication.

In paper, kaolin is used as a filler and for coating. As a filler, it is used to fill the interstices of the paper fibres. Kaolin is less expensive than paper pulp and, therefore, effectively lower paper production costs. Kaolin has advantages as high glass, brightners and low viscosity at high solids contents. Existing units may improve the quality of processed kaolin.

MARKET POTENTIAL

In Gujarat State, 16 legivation plants are in operation. On the basis of prospecting results of china clay deposits in Kachchh, new mines have come into operation. Refining of 300 tonnes per day require 600 crude ore, while an average 2000 crude ore is exploited per day in the State. From the above statistical data, it reflects that there exists a gap in refining and crude ore production. Foilowing are the location of major levitation plants :

Major Units	*Refining Capacity (tonnes/day)*
Amrapalli & Co., Arasodia, Sabarkantha	30
Eklera China Clay Works, Eklera, Sabarkantha	30
Bharat Natwarlal Thakaor, Bhachau, Kachchh	02
Sri Ram International, Madhapur, Kachchh	05
Kachchh Minerals, Manfera, Bhuj	30
HD Enterprise, Bhuj	20
Ashapura China clay Works, Bhuj	20

Total refining capacity per day is approximatrly 300 tonnes by all units.

Country has 340 paper plants with 35.50 lakh production capacity, while in Gujarat 55 paper plants with 3.5 lakh capacity are in operation. At present, coating clay is imported. One sq.mtr. paper pulp will need 4 gm. coating clay. Looking to the production, State will need an average 14-15,000 tonnes paper coating clay. At present, no unit is engaged in paper coating processing.

MANUFACTURING PROCESS

Kaolin refining process rely on pasticlesize separation. Mined raw china clay is crushed by stationery raw crusher. Crushed kaolin may be dispersed in soft water to turn into slurry. With the application of hydrocyclone separation, it is possible to produce paper coating grade clay. In this

process, traditional methods of processing such as centrifuging, air floating have proved no longer good. The mozley 10 mm hydrocyclone is a high performed small diameter unit offering 50 cut points in the 2 to 5 micron size range. The hydrocyclone, which is injection moulded in polyurethane for good abrasion resistance or PVDF for corrosive applications is fitted in multiples of 60 numbers.

Mozley high performance 10 mm hydrocyclones each filted with ceramic lined Vortex finers (3.2 mm) & SPiGOTS (1.5 mm) system will have two-way in-line feed distributor with trash screen. One feed pressure gauge. One meter long overflow and underflow pipes at system discharge points. The individual hydrocyclones screw together in two sections allowing easy replacement of one without disturbing the remainder 10 mm hydrocyclones are a low cost alternative to centrifuges. They offer lower power consumption, more consistant product quality and considerably easier maintenance.

All operated from single feed pump. Desired 30,000 litre slurry with 100 PSI pressure is feed to the assemblies. Hydrocyclone system underflow will separate coating clay slurry which will be dried in a buell drier. Dried clay can be packed in 50 kg. paper bag in packing section.

RAW MATERIAL

Gujarat produces 6% of total china clay of the country. An average 5 lakh tonnes of raw china clay is exploited. Plant can procure its plant feed of 30,00,000 litres slurry from the captive mines. Captive mines can be procured in the Sabarkantha, Mehsana districts. Visnagar, Vijapur area is a clay zone in Mehsana district. Kot, Ransipur, Arsodia, Eklera, Kadoli Davad are potential villages for captive mines. In case of Banaskantha, Aluvas, Dhokanwada of Santalpur taluka is good area for captive purposes.

SUGGESTED LOCATION

Plant can be erected in subsidy area of Mehsana and Sabarkantha district. Ideal location will be Himatnagar in Sabarkantha district, Bhachau in Kachh district.

COST OF PROJECT

The project envisage to operate at an inlet pressure of 100 PSI. The required throughout will be of the order of 30 M^3/hr. Plant will treat 3,00,000 litres per day on 10 hrs. operating day basis, involving Rs. 5.0 crores with 20 tonnes per day refined capacity.

			[Rs. in crores]
1)	Land	:	0.02
2)	Plant & Machinery	:	2.00
3)	Capital Money	:	0.80
4)	Captive Mechanised Mines (with mining machinery)	:	2.00
	Total	:	4.82
	Say	:	5.00

PLANT & MACHINERY

Sl.No.	Description	Qty.(Nos)	Price (Rs.)
1.	Blunger (3.04 mtrs. dia)	1	25,000
2.	Agitator (5.22/3.48 mtrs)	3	60,000
3.	One Mozley, Hydrocyclone system consisting of two Nos.of Mozley C1030C Assemblies.	60 Nos.	
4.	Two-way inline feed distributor with Trash screen.	hydrocyclones assemblies	
5.	One Feed pressure gauge.	2 Nos.	
6.	1 Mtr. long overflow & underflow pipes at the system discharge point.		
7.	Slurry pumps		2,00,000
8.	Miscellaneous		1,00,000
9.	Buell drier		20,00,000

Captive Mines:

The project involves captive mines of china clay of 10 hectares area with 50 tonnes per day output from the mines.

GOVERNMENT POLICY

1. China clay captive mines can be procured from the State Government as per Mineral Concession Amended Rules, 1988 by filing lease applications to the State Government in prescribed forms.
2. Erection of Hydrocyclone assemblies can be done by the firm as per proposal.
3. Before installation of above assemblies, it is advisable to test slurry. In the laboratory, model of the company or pilot model can be erected first.

TECHNOLOGY SUPPLIER & ERECTOR

1. Richart Mozley (India) Ltd
   Unit House, P.40 Block "B"
   New Alpore, Calcutta-700 053
   Tel: 478-1311/1210/3630
   Fax: 91-033-4783366,4783748

2. E.C.C. International
   1015 Arlington Business Park
   Thedle, Reading Berkshire
   U.K.

Firm can erect hydrocyclone assemblies after testing slurry in their laboratory.

RISK FACTOR

1. Procurement of captive mines from the State Government will depend upon passing of Mine Plan by IBM, Government of India.
2. Prospected china clay pockets are mostly in the private land, so potential land have to be purchased from the owners.
3. Recovery of paper coating clay as per BIS standard depends on the gensis of china clay deposit. If the particle size of kaolin is uniform, recovery will be good.

4. Soft water requirement for preparing slurry per day will be 50,000 litres per day with high pressure pump.

PRICE TARIFF OF THE MOZLEY MODELS

		C-1010(Pound) (A) (Lab. Model)	C-1030(Pound)(B) (Pilot Model)
Ex-works UK Price		434.70	6,035.12
CIF Bombay charges		160.00	276.00
		594.70	6,311.12
		10 MM hydrocyclones (Pounds)	1" hydrocyclones (Pounds)
A.	Price of system (Ex works UK)	31,050.00	6,920.00
B.	CIF charges	2,442.00	2,442.00
C.	System commissioning charges	1,630.00	1,630.00
	Total	35,122.00	10,992.00
	+ Import Duty @ 20%.		

CHINACLAY LEVIGATION

INTRODUCTION

Kaolin is essential raw material for ceramics. It is used in textiles, paper, rubber, paint and cosmetics. In addition to above industrial application, new ones are still being discovered. Ceramics grade china clay is mostly processed by the present parties. Low grade deposits can be beneficated by adopting modern techniques like elutriation, forth floation and electrostatic and magnetic separation. High quality china clay used in manufacture of electronics, drugs and pharmaceuticals is still imported.

MARKET POTENTIAL

In Gujarat State, 16 legivation plants are in operation. On the basis of prospecting results of china clay deposits in Kachchh, new mines have come into operation. Refining of 300 tonnes per day require 600 crude ore, while an average 2000 crude ore is exploited per day in the State. From the above statistical data, it reflects that there exists a gap in refining and crude ore production. Following are the location of these levitation plants :

Major Units	*Refining Capacity (tonnes/day)*
Amrapalli & Co., Arasodia, Sabarkantha	30
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Kachchh Minerals, Manfera, Bhuj	30
HD Enterprise, Bhuj	20
Ashapura China clay Works, Bhuj	20

Total refining capacity per day is approximatrly 300 tonnes by all units.

MANUFACTURING PROCESS

Mined Kaolin (china clay) is a soft friable mass which must be reduced to a fine particle size before use. The crude clay may be crushed, or it may be dispersed in water to turn into slurry. Process starts with blunging, which is the initial disintegration of crude clay lumps into their natural particle size. The presence of a de-functioning agent causes the suspension to change from a plastic condition into a watery state, in which it is pumped to the refining plant. Processing first involves a degritting procedure to remove major contamination. Then centrifugal size classification into closely controlled fraction is performed. After this clay is bleached to remove the colouring caused by iron compound and then thickened before being filtered on a filter press. Thereafter, caps are dried. In brief, water wash Kaolin technique washing is carried out to separate associated immpurities like quartz, feldspar, mica any coloured mineral, soluble salt and organic matter. The entire washing operation consists of several steps :

1. Crushing and grinding
2. Slabing
3. Blunging and separation into different size frictions

4. Settling

5. Filtering and drying of the filter cake

The operation is carried out in large settling tanks. The clay is filtered from its water suspension either by plate filter pressed or by continuous drum type filter equipments. The rotary of tunned type dries are used to dry up the filter cakes. Washeries are constructed according to the need.

PLANT AND MACHINERY

1. Filter Press (80 chambers)
2. Diaphram pump
3. Clay mixing blunger
4. Megnate plate
5. Screening plate
6. Electric motor 10 HP two for blungers and two for centrifuger
7. Centrifugal unit
8. Belt conveyor 116'
9. Electric motor 7 HP one for diaphram and one for conveyors
10. Clay mixtures
11. Water pummp 3"-4" sub.

RAW MATERIALS

Gujarat produces 6% of the total china clay of the country. Mehsana, Kachchh and Sabarkantha are leading districts where china clay is exploited in private sector. There are 79 mining lease holders actively engaged in china clay mining. All lease holders are not operating levigation plant. During a year, average 4 to 5 lakh tonnes of raw china clay is exploited. Production of china clay has increased considerably from Kachchh during last 3 years.

PROJECT SIZE

Rs.25 lakhs for 25 TPD refinery.

	Rs.in lakhs
Cost of land(Approx.)10,000 sq.mmts.@ Rs.10/-)	1.00
Building & civil construction	5.00
Plant & machinery	15.00
Margin money	4.00
Total	25.00

UTILITIES

Power 100 HP
Employment 100 persons

Civil Construction

		Dimensions	Nos.
a)	Levigation channels	500'x2'x1	4
b)	Settling	60x20x6	3
c)	Slurry tanks	100'x25'10	3
d)	Drying chammbers	500'x300'	2

SUGGESTED LOCATIONS

Plant can be erected in Bhachau, Bhuj, Mandvi in Kachchh districts on the basis of Kachchh china clay resources. In case of Sabarkantha and Mehsana district resources, it can be located at Vijapur or Hiatnagar.

GOVERNMENT POLICY/KEY ELEMENTS

China clay mining lease can be given as per Mineral Concession Amended Rules, 1988.

Priority will be given to those application who intend to erect levigation plant. Traders are discouraged for acquiring mining lease. Gujarat Pollution Control Board's clearance is necessary for water discharge.

LIST OF PLANT AND MACHINERY SUPPLIERS

Cerammic Machinery Blunger etc.

1. Kusum Engineering Co.
   25 Swallo Lane, Calcutta-700 023
2. Hariyana Udyog
   Rajganjpur-770 017
3. Rashtriya Engg. Works
   GT Road, Batala-143 505

Hydraulic Press

1. Acro Whitney
   Plot No.39, Block-D2
   MIDC Estate, Chinchwad, Pune
2. Crescent Iron & Steel Corp. Ltd
   Industrial Estate, Lal Baug
   Bombay
3. KG Khosla & Co Pvt. Ltd.
   Deshbandhu Gupta Road, New Delhi

Ceramic Machinery

1. Panchal Jivanlal Shivlal
   Opp.Civil Hospital (Old)
   Gheekanta Road, Ahmedabad-1
2. Lokmanya Engg. Works
   26 Bharatkhand Cotton Mills Compound
   Naroda Road, Ahmedabad
3. Makwana Engg. Works
   15 New Market, Surendranagar
4. United Engg. Corp.
   188 GIDC Estate, Makarpura, Baroda
5. Modern & Fabrication Engg.Works
   Saijpur, B/h Temple
   Naroda Road, Ahmedabad
6. Amar Engg. Works
   Morvi

LIST OF RAW MATERIAL SUPPLIERS

1. Shree Ram Mine-Chem International
   GIDC Estate, Madhapur-370 020, Dist. Kachchh
2. Amarpali & Co
   289 New Cloth Market, Outside Rajapur Gate, Ahmedabad-380 002
3. Eklara China clay Works
   8 Janpath Comm. Centre, 4th Floor, Opp. Capital Comm. Centre
   Ashram Road, Ahmedabad-380 006

UTILIZATION OF RAJPARDI PLASTIC CLAY (BHARUCH) IN CERAMIC SECTOR

In the State, six hundred and fifty small scale ceramic units are in operation for the manufacture of crokery, sanitaryware, insulators, wall tiles, refractory, etc. Major organised companies like Madusudan, Decora, Somany, Bell are in the wall tiles production in the State. New industrial houses like Mittal Group and Modi Rubber are planning major wall tile units in the state. Rajpardi clays are evaluated for their suitability by CGCRI (Naroda Centre). The suitability in glazed wall tiles, low tension insulators, sanitaryware, crokerywares & refractory manufacturing as a replacement of Bikaner clay were studied on a factory level. The abstract of all the five study reports carried out by CGCRI (Naroda Centre) are given for the guidance of users.

1. DEVELOPMENT OF SANITARYWARE THROUGH OPTIMUM UTILISATION OF RAJPARDI CLAY

ABSTRACT

The conventional sanitaryware composition consisted of three major traditional raw material clays (china and ball clays), quartz and potash felspar. These raw materials are althotgh available in plenty but the demand for the same in the existing and the newceramic units is gradually increarsing. With regard to plastic clay, the ceramic industry has to depend on Bikaner clay, the only satisfactory plastic clay of India. But the said clay is becoming expensive and the reserves are also getting depleted fast. Plastic clay provides green strength to the articles, help in fabrication of the same and reduces losses due to breakage. Besides, Bikaner and Than clays are available in hard lumps and take more time for blunging. Rajpardi clay is available in soft lumps which take less time for blunging.

In view of above, Rajpardi clay was progressively introduced in replacement of Bikaner and Than clays and its effects on physical thermal and mechanical properties were studied and then compared with the properties as mentioned in the Bureau of Indian Standard specification for Sanitarywares.

Progressive incorporation of Rajpardi clay in replacements of Bikaner and Than clay in the standard body composition resulted in gradual increase of dry shrinkage and dry strength of specimens in the body mixes. It has also resulted in early vitrification of the body mixes. The body RPS-4 containing 20% Rajpardi clay in complete replacement of Bikaner clay showed water absorption of 0.06% at 1300°C where as the body mix (RPS-6) containing 30% of Rajpardi clay showed 0.15% water absorption at 1250°C. Fired strength of matured body RPS-4 was 766.6 kg/cm^2 and the same for RPs-6 was 745.60 kg/cm^2.

It is also evident from rheological properties of casting slip of different body mixes that the additions of Rajpardi clay even upto 30 wt% had no adverse effect on the properties of casting slip.

All these factors would lead to the economical production of improved quality sanitaryware through the replacement of Bikaner plastic clay by Rajpardi plastic clay at the first instance and finally through the replacements of both the plastic clays namely, Bikaner and Than clays.

Source: Central Glass & Ceramic Research Institute, Naroda Centre, Ahmedabad-382 330

2. DEVELOPMENT OF BUFF COLOURED EARTHENWARE QUALITY GLAZED WALL TILES THROUGH OPTIMAL UTILISATION OF RAJPARDI CLAY

ABSTRACT

The objective of this work is to utilise Rajpardi clay replacing traditional plastic clays like Than and Bikaner clays, which are presently being used in the production of earthware glazed wall tiles in the State of Gujarat and elsewhere. the development and utilisation of this clay in the production of glazed wall tiles will make this State sufficient and less dependent onthe neightbouring states for plastic clays. A few years back there were hardly any tile manufacturing units in the State, but today the whole scenario has changed. A large number of units have sprung up in the recent years and more entrepreneurs are also taking interests in setting up tile manufacturing units due to increased building activities in the country.

It is, therefore, essential that new sources of plastic clays are tapped and evaluated for their suitability in the manufacture of wall tile to tide over the problem of fast depleting, non renewable reserves of traditional plastic clays in the country.

The Rajpardi clay being highly plastic in nature cannot be used alone, but in combination with other comparatively less plastic clays like Than & Bikaner clays for achieving optimum plasticity and adequate compaction while pressing of wall tiles.

An increase in the green strength can be effected by incorporating more plastic clays like Rajpardi in the tile body which would favourably influence the final output through the reduction of losses due to cracking and chipping while stacking of the tiles for biscuit firing.

It was observed that the incorporation of Rajpardi clay in the tune of 25 wt% is the optimum condition in achieving the requisite physical properties in wall tiles.

Source: Central Glass & Ceramic Research Institute, Naroda Centre, Ahmedabad-382 330

3. DEVELOPMENT OF PRESSED LOW-TENSION INSULATORS THROUGH THE OPTIMUM UTILISATION OF RAJPARDI CLAY

ABSTRACT

Rajpardi clay was progressively incorporated as a replacement for Bikaner clay initially and then Than Plastic Clay in the conventional L.T. Insulator body composition. Standard composition consisted of 20% Calcined quartz, 25% Potash felspar, 25% China clay, 10% Than clay, 15% Bikaner clay. It altered the physical properties significantly, especially the gradual increments in green strength, fired strength, bulk density, etc. followed by decrease in water absorption and apparent porosity. Incorporation of Rajpardi clay in replacement of Bikaner clay in the standard body composition of low tension insulator was found beneficial and produced improved properties. Progressive incorporation of Rajpardi clay in place of Bikaner and Than clays in L.T insulator body resulted in the increase in strength, decrease in water absorption and apparent porosity of the specimens.

From the fore-going discussion it is evident that the mixes marked RPLT-3 with the complete replacement of Bikaner ball clay by Rajpardi clay met all the relevant properties for the manufacture of low tension insulators. The properties were also superior to that of the standard body mix. The body mix marked RPLT-5 containing the full quantity of Rajpardi clay in replacements of both Bikaner and Than clays also developed the relevant properties suitable for the production of low-tention insulators except the fired shrinkage which was slightly on the higher side. The low tension insulators made from the body mixes marked RPLT-3, & 5 also conformed to the requirements of low tension insulators according to the Indian standard specification.

Source: Central Glass & Ceramic Research Institute, Naroda Centre, Ahmedabad-382 330

4. DEVELOPMENT OF CROCKERY WARES THROUGH OPTIMUM UTILISATION OF RAJPARDI CLAY

ABSTRACT

Rajpardi clay is available in plenty as overburden in the lignite deposit situated at Bhoori village in Bharuch district of Gujarat State. The mine is opeprated by Gujarat Mineral Development Corporation. Rajpardi clay contained residue of about 0.6% on 45 micron IS sieve whereas Bikaner clay contained the same to about 6.73 %. Other properties like water of plasticity, workability and dry strength are quite good and higher than that of Bikaner and Than clays.

Conventional stoneware body is prepared from clay, quartz ad felspar, a triaxial body composition in which plastic clays like Bikaner and Than are used generally. Plastic clays give green strength, help in fabrication of ceramic wares and reduce losses during transportation. Both the clays are available in hard lumps. The Bikaner clay available from Rajasthan is also expensive. The clays take more blunging time due to the fact that these are hard and compact lumps. Rajpardi clay is available in soft lumps, contained fine particles and expected to take less blunging time. The plasticity of this clay is also good and expected to be helpful in the shaping process of crockerywares.

In view of above Rajpardi clay was progressively incorporated in replacements of Bikaner and Than clays and the effects on physical, thermal and mechanical properties were studied and also compared with the properties as mentioned in the BIS specification of industrial stoneware for general purposes.

Progressive incorporation of Rajpardi plastic clay initially in replacement of Than plastic clay in the standard crockery body composition resulted in the gradual increase in plasticity and unfired strength in the body mixes. The increase in unfired strength was found to be about 44 and 59 percents for RPC-3 with complete replacement of Bikaner by Rajpardi and for RPc-5 with complete replalcements of Bikaner ball clay and Than fire clay by Rajpardi respectively.

The incorporation of Rajpardi clay in the body mixes had resulted in early vitrification. The body mix RPC-5 showed a reduction of the maturing temperature by 50°C compared to that of the standard body. The body mix RPC-3 showed a water absorption of about 0.07% at 1300°C whereas the same in case of the standard body (RPC-Std) was 0.132%. The fired strengths of the matured specimens of body mixes RPC-3 and RPC-5 were also high. An increase in strength of about 5.5% was noticed in RPC-3 body at 1300°C in comparison to that of standard body. The increase in strength was about 11.7% in RPC-5 in comparison to that of Std. Body coupled with a decrease in maturing temperature of about 50°C in RPC-5 body.

All these factors would lead to a more economical production of improved stonewares which contain Rajpardi clay either in replacement of Bikaner clay or in the replacements of both Bikaner and Than clays.

Source: Central Glass & Ceramic Research Institute, Naroda Centre, Ahmedabad-382 330

5. UTILISATION OF RAJPARDI CLAY IN REFRACTORIES

ABSTRACT

Gujarat Mineral Development Corporation (GMDC), a Government of Gujarat Undertaking is engaged in mining of various minerals on a commercial basis in different parts of Gujarat. GMDC is mining lignite near Rajpardi in Vaghadia Taluka of Surat. A plastic clay, which occurs as overburden over the lignite deposit is not utilised at present for any gainful purposes. A preliminary investigation showed that this clay if properly mined and segregated as a mineral, can be utilised in various industries. In this particular investigation, the Carbonaceous type clays identified and marked as NHP(L) and NHP(M) have been studied for utilisation in the manufacture of refractory bricks of IS-6 quality.

It is possible to manufacture IS-6 brick by incorporating 10 percent by weight of NHO(M) clay, 10 percent by weight of NHO(L) clay along with 40 percent by weight of Than clay and 40 percent of refractory grog. The refractory mix was pressed in the friction press. But the first stroke has to be slowly applied otherwise lamination cracks developed in the pressed brick. The firing of the brick has to be carried out slowly inorder to compeltely oxidise the organic matter present in the clay. The amoutn of carbonaceous matter in the clay limited the incorporation of these clays in refractory to about 20 percent as additional increasing the percent apparent porosity. The bricks have to be fired to higher temperature in commercial kiln in order to meet the ISS:6-1983 specification for Apparent porosity.

These clays can also be used in the manufacture of insulating bricks looking into the content of carbonaceous matter in the clays and other properties.

Source: Central Glass & Ceramic Research Institute, Naroda Centre, Ahmedabad-382 330

ANNEXURES

ANNEXURE-1

PHYSICO CHEMICAL ANALYSIS OF KACHCHH CHINACLAY

Sr. No.	Prperties	D-59 (83-84) Mamuara	D-58 (83-84) Nadapa	D-43 (84-85) Raminhas	D-46 (84-85) Gogadian	D-9 (87-88) Kanderai	Bhachau
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1.	Raw colour & impurities	White, fairly hard lummps, black particles are visible.	White, fairly hard lumps. Many small black particles are visible. Mica particles also visible.	Salmon pink.	White	White	Pale white, hard, contains transparei grit & fine mica.
2.	Slaking nature	Nonslaking	Nonslaking	-	-	-	Very slow.
3.	Levigated colour	-	-	-	-	-	Pale white.
4.	Plasticity by hand feel	Moderate (Moderate to fair)	Moderate (Moderate to fair)	Fair (Moderate to fair)	Moderate	Fair	Fair to good.
5.	% water of plasticity (dry basis)	38.50	35.43	28.11	26.81	27.31	31.15
6.	Dry shrinkage at 110°C	4.0	4.0	4.0	4.0	5.0	7.0
7.	Fired properties at 1250°C :						
8.	Fired colour	White light colour. Very small light brown specks, some cracks visible.	White light colour. Very small light many brown specks, some cracks are visible.	Brown colour due to very small brown specks spread on test pieces. No cracks.	White. No cracks occassionally some brown specks.	White colour. No cracks or specks are visible.	White. No patches or cracks developed.
9.	Total shrinkage	19.00	16.00	9.00			
10.	Vitrification	None	None	None			

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
11.	Fired properties at 1450oC :						
12.	Fired colour	White. Brown specks & many cracks.	White. Many small brown specks, some cracks are visible.	Light salmon pink to brown.No cracks. Many small brown specks.	Yellowish white. Small brown specks. Some cracks.	Champagne colour. No cracks or specks are visible.	Dull white very small brown patch appear. No crack developed.
13.	Total shrinkage	21.00	19.00	14.00	10.00	12.00	16.00
14.	Vitrification	Fair	Fair	High	Fair	Fair	None
15.	Chemical analysis :						
	SiO_2	45.43	43.14	61.85	63.28	61.21	52.21
	Al_2O_3	35.50	39.43	25.72	24.49	25.84	33.43
	Fe_2O_3	0.65	0.40	0.74	0.74	1.04	0.75
	TiO_2	1.58	1.42	1.59	1.82	1.32	0.32
	CaO	0.34	0.27	0.20	0.07	0.41	0.63
	MgO	Nil	Nil	0.07	0.02	0.10	0.05
	Na_2O	0.28	0.62	0.41	0.17	0.50	0.22
	K_2O	0.03	0.03	0.30	0.19	0.63	0.14
	L.O.I	13.99	14.16	9.27	8.99	9.10	12.66
16.	DTA Endothermic Peak temp.	530°C	530°C	100°C 525°C	100°C 530°C		
	Exothermic	985°C	970°C	955°C	980°C		
17.	Constituent	Kaolinite	Kaolinite	Kaolinite	Kaolinite		

PHYSICO CHEMICAL ANALYSIS OF AMRELI CHINACLAY

Sl.No.	Properties	Balaniwav/92-93/D-12	Devka
1.	Raw colour & impurities	Dull white	
2.	Slaking nature	-	
3.	Levigated colour	-	
4.	Plasticity by hand feel	Fair	
5.	% watter of plasticity(dry basis)	45.26	
6.	Dry shrinkage at 110^{0} C	4.00	
7.	Fired properties at 1250^{0} C :		
	i. Fired colour	Light cream colour. No cracks,but many brown specks are available.	
	ii. Total shrinkage	22.00	
	iii. Vitrification	Fair	
8.	Fired properties at 1400^{0} C :		
	i. Fired colour	Sunshine colour, many cracks are developed like spider web but match due to vitrification.	
	ii. Total shrinkage	22.00	
	iii. Vitrification	Fair	
9.	Chemical analysis		
	SiO2	42.17	50.77
	Al2O3	37.46	31.90
	Fe2O3	2.16	3.28
	TiO2	0.22	0.52
	CaO	Ab	0.42
	MgO	Ab	Trace
	Na2O	0.35	0.86
	K2O	0.03	0.04
	LOI	13.54	12.32
10.	Specific gracity	2.66	
11.	Particle size :		
	45 micron	6.2	
	40 - 45	0.4	
	30 - 40	0.8	
	25 - 30	0.8	
	20 - 25	1.2	
	15 - 20	1.9	
	10 - 15	3.0	
	8 - 10	1.8	
	5 - 8	5.1	
	3 - 5	7.3	
	2 - 3	6.6	
	2	64.9	

Mineralogical Composition(X-ray diffraction): Sample contains mainly kaolinite & accessary mineral is Anatase.
Thermal Behaviour-DTA: Endothermic 530^{0}C sharp. Exothermic peak at 970^{0}C. Sample contains Kaolinite.

ANNEXURE-III

PHYSICO CHEMICAL ANALYSIS OF RAJPARDI CHINACLAY, BHARUCH DISTRICT

Sr.No.	Properties	
1.	The clay was levigated without addition of any electrolyte.	
	i. Slakaing nature	: Very quick
	ii. Clay yield	: 53.70%
	Mica channel	: 8.90%
	Sand settling tank :3	: 3.20%
	" : 2	: 9.60%
	" : 1	: 15.05%
	Grit (in blunger)	: 9.55%
		100.00
	iii. Clay yield	: 53.70%

2. Complete chemical analysis :

SiO_2	38.10	Al_2O_3	34.94
Fe_2O_3	4.62	TiO_2	3.50
CaO	2.03	MgO	0.16
Na_2O	1.63	K_2O	0.04
L.O.I	14.90		

3. % water of plasticity — 41.38
4. Atterberg's Number — 23
5. Plasticity (by hand feel) — Very good
6. Particle size distribution by Andreasen's pipette ethod (microns:)

	%		%
25	9.0	15-25	4.0
10-15	3.5	8-10	1.5
5-8	3.5	3-5	2.5
2-3	2.0	1-2	3.5
1	70.5		

7. % Linear shrinkages

Dry (at 110 °C)	4.55%
Fired (at 1350 °C)	19.09%

8. Fired colour (at 1350 °C) — Creamish
9. PCE — 31 1/2 - 32 (close to 31 1/2)

REMARKS:

From the tests conducted above, the clay on washing develops good workability but for its creamish fired colour cannot be used for fine whitewares. However, it can be used for manufacture of stoneware crockeries, LT insulators sanitaryware, refractory. Recent application study carried out by CGCRI has established that it can replace Binaker clay in the body formation. Abstract of Papers for Rajpardi clay applications are incorporated in the Chapter on Project Profiles. Ceramic unit can procure clay from GMDC Bhuri Mines, Bharuch.

CHEMICAL ANALYSIS OF CHINA CLAY OF ALUVAS, DHOKAWADA, SANTALPUR (BANASKANTHA DIST.)

Properties	Aluvas	Dhokawada	Santalpur
Silica (SiO_2)	65.80	44.76	65.80
Alumina (Al_2O_3)	22.78	35.35	22.78
Ferric Oxide (Fe_2O_3)	0.57	1.00	0.57
Titanium Dioxide (TiO_2)	0.78	1.75	0.78
Manganese Oxide (MnO)	0.02	-	0.02
Calcium Oxide (CaO)	0.38	1.20	0.38
Magnesium Oxide (MgO)	-	1.25	0.30
Potassium Oxide (K_2O)	0.07	0.36	0.07
Socidum Oxide (Na_2O)	0.97	0.77	0.97
Loss on ignition -	8.32	13.56	8.32
Specific gravity	2.63		2.63
Bulk density (after 50 taps)	0.94 g/ml		0.94 g/ml
PH (10% solution)	7.7		2.65 present
Moisture at 105°C	2.65 present		
Grit	4.96 present		4.96 present
Oil Absorption	34.04 present		34.04 present
Material retained on 100 mesh B S Sieve	12.5 present		12.5%
Material retained on 250 mesh B S Sieve	13.1 present		13.1%

Field Properties at 1250°C:

a)	Colour and visual examination:	Buff white colour. Number of cracks developed on upper surface of the test piece is covered with glassy materials in the form of melted material.
b)	Linear shrinkage	18%
c)	Vitrification	Fair

Field Properties at 1400°C:

a)	Colour and Visual examination:	White colour, Number of cracks developed on upper side of the test piece is covered with glassy materials in the form of melted material. Whiteness is more than that at 1250°C temperature. Some brown patches developed on the surface.

Properties	Aluvas	Dhokawada	Santalpur
b) Linear shrinkage	17%		
c) Vitrification	High		
Analytical Report:			
Colour and visual imapurities	White colour. Visual impurities are present.		
Slacking nature	Quick		
Plasticity by hand feel	Good	Moderate	
Water of plasticity	57.82"		
Dry linear shrinkage at 105 °C	14.0%		
Particle Size Analysis (in microns)			
25		3.0	21.0
15-25		2.0	12.5
10-15		1.5	9.0
8-10		1.5	4.5
5-8		3.0	9.0
3-5		6.0	8.0
2-3		5.0	5.5
1-2		13.0	6.5
1		65.0	24.0

CHEMICAL ANALYSIS OF WHITE CLAY FROM JITOD, TA. HIMATNAGER, DIST. SABARKANTHA

A Appearance and raw character:

1.	Raw colour and general appearance	:	White lumps no grit is visible. Some brown coloured particles are visible on some portion of the surface of the original lumps.
2.	Hardness	:	Hard
3.	Slaking nature	:	Very slow
4.	pH	:	8.8
5.	P E C	:	4.7 eq/100 gms.
6.	Recovery of washing	:	47.8%
7.	Levigated colour	:	White

B. Green (Unfired) Properties:

1.	Plasticity by hand feel	:	Fair to good
2.	Water of plasticity (On dry base)	:	33.82
3.	Atterberg's number	:	26
4.	Dry linear shrinkage on plastic length	:	5.0/0

C. Chemical analysis:

SiO_2	:	59.08
R_2O_3	:	46.65
Al_2O_3	:	53.02
Fe_2O_3	:	2.3
TiO_2	:	9.33
CaO	:	0.95
MgO	:	Traces
Na_2O	:	0.50
K_2O	:	0.05
L O I	:	13.24

D. Fired Properties:

i) Fired Properties at 1250°C:

1. Fired colour and visual examination	:	Yellowish white many cracks developed.
2. Linear shrinkage	:	18%
3. Water absorption	:	8.34%
4. Vitrification	:	None

ii) Fired properties at 1400°C:

1. Fired colour and visual exammination	:	Greyish yellow cracks are minimised due to vitrification.
2. Linear shrinkage	:	21%
3. Water absorption	:	1.98% *
4. Vitrification	:	High

* The test pieces showed many cracks hence water absorption data only approximate.

Source: Directorate of Geology and Mining, Ahedabad.

PHYSICO CHEMICAL ANALYSIS OF SABARKANTHA CHINACLAY

Sl.No.	Properties	Eklera	Arsodia	Daavad
1.	Raw colour & impurities	Pale white with grey grit particles.	Pale white with grey grit.	Pale white with grey grit and felspathic impurities.
2.	Slaking nature	Fair	Fair to quick	Quick
3.	Levigated colour	Yellowish white	Pale white	Pinkish white
4.	Plasticity by hand feel	Good	Good	Good
5.	% water of plasticity (dry basis)	39.21	33.27	33.74
6.	Dry shrinkage at 110° C(%)	6.00	5.00	5.01
7.	Fired properties at 1250° C:			
7.1	Fired colour	White with brown specks	White	Pale white with small brown patches
7.2	Total shrinkage (%)	16.00	11.00	12.00
7.3	Vitrification	None	None	None
8.	Fired properties at 1450° C:			
8.1	Fired colour	Buff white	white	Pale with full of brown patches
8.2	Total shrinkages	17.00	14.00	19.00
8.3	Vitrification	Fair	None	Slight
9.	Chemical analysis:			
	SiO2	46.34	50.34	48.85
	Al2O3	32.64	34.52	30.01
	Fe2O3	1.12	1.00	1.44
	TiO2	1.04	0.50	0.80
	CaO	4.18	0.77	0.32
	MgO	0.31	Tr	1.66
	Na2O	0.22	0.38	-
	K2O	0.36	0.20	0.24
	L.O.I	14.26	11.78	13.90
10.	DTA Endothermic	98° C	65° C	75° C
	Peak temp.	560° C	580° C	565° C
	Exothermic	180° C	225° C	175° C
	Peak	992° C	1005° C	1005° C
11.	Dominant mineral	Kaolinite with Halloysite	Kaolinite	Kaolinite
12.	Impurities	Calcite	-	Calcite

PHYSICO CHEMICAL ANALYSIS OF MEHSANA CHINACLAY

Sl.No.	Properties	Kadoli	Kot	Ransipur
1.	Raw colour & impurities	Yellowish white salt contains sand material.	Pale white	Pale white
2.	Slaking nature	Quick	-	-
3.	Levigated colour	Pale white	Yellowish white	white (slightly pinkish)
4.	Plasticity by hand feel	Good	Good	Good
5.	% water of plasticity (dry basis)	35.79	38.90	43.25
6.	Dry shrinkage at 110^{o} C(%)	5.00	6.00	7.00
7.	Fired properties at 1250^{o} C:			
7.1	Fired colour	Pale white rarely very small brown patches, some cracks	White	White
7.2	Total shrinkage (%)	18.00	13.00	13.50
7.3	Vitrification	None	None	None
8.	Fired properties at 1450^{o} C:			
8.1	Fired colour	Greyish white with brown patches.	Buff white with some brown patches	White (with buff tinge)
8.2	Total shrinkages	19.00	15.00	20.00
8.3	Vitrification	Fair	Fair	Fair
9.	Chemical analysis:			
	SiO2	47.25	48.32	32.65
	Al2O3	36.43	31.22	35.68
	Fe2O3	0.94	1.10	0.74
	TiO2	0.48	0.32	0.33
	CaO	0.56	4.63	3.80
	MgO	0.03	Tr	0.113
	Na2O	0.22	0.18	0.22
	K2O	0.23	0.24	0.06
	L.O.I	13.95	14.05	14.43
10.	DTA Endotheric	70^{o} C	90^{o} C	140^{o} C
	Peak temp.	570^{o} C	565^{o} C	560^{o} C
	Exothermic	240^{o} C	1000^{o} C	1005^{o} C
	Peak	992^{o} C		
11.	Domminant mineral	Kaolinite with Halloysite	Kaolinite Halloysite	Kaolinite Halloysite
12.	Impurities	-	Calcite, Quarts Albite	Calcite, Quartz Albite

PHYSICO CHEMICAL ANALYSIS OF SURENDRANAGAR CHINACLAY

Sl.No. (1)	Properties (2)	Bavli (3)	Kankavati (4)	Khod (5)
1.	Raw colour & impurities	Fairly hard white lumps.	Fairly hard white brittle lumps	Moderately hard brittle white & pale white lumps.
2.	Slaking nature	Fair	8.50	8.30
3.	pH	8.35	8.50	8.30
4.	BEC MMeq/100 gm	6.57	3.55	3.03
5.	Whiteness % (Dry basis)	69	75	70
8.	Dry shrinkage at 110° C	5.00	3.00	5.00
9.	Atterberg number	25	16	19
10.	Grit content retained on 45 mmicron sieve %	4.90	29.64	19.80
11.	Fired properties at 1250° C:			
11.1	Fired colour	Pale white with small brown specks	White with small small brown specks	White with small small brown specks
11.2	Total shrinkage(%)	9.00	7.00	9.00
11.3	Vitrification	None	None	None
11.4	Water absorption %	11.09	15.11	16.18
12.	Fired properties at 1400° C:			
12.1	Fired colour	Beige	Yellow with brown small specks.	Yellowish brown with brown specks
12.2	Total shrinkages	13.00	10.50	11.00
12.3	Vitrification	High	Fair	Fair
12.4	Water absorption%	2.16	5.53	6.72
13.	Chemical analysis %:			
	SiO2	60.75	64.56	61.72
	Al2O3	26.50	24.94	26.44
	Fe2O3	1.04	0.88	0.80
	TiO2	1.41	1.40	1.41
	CaO	0.13	0.13	0.13
	MgO	0.03	0.03	0.03
	Na2O	0.53	0.53	0.53
	K2O	0.45	0.33	0.23
	L.O.I	9.11	7.43	8.46

(1)	(2)	(3)	(4)	(5)
14.	Rational analysis %:			
	Kaolinite	61.39	57.61	62.74
	Muscovite	3.83	2.76	1.90
	Albite	4.47	4.41	4.45
	Hematite	1.04	0.80	0.80
	Rutile	1.41	1.40	1.41
	Calcite	0.23	0.23	0.23
	Magnesite	0.06	0.06	0.06
	Free quartz	27.57	32.73	28.41
15.	Particle size analysis % undersize in microns:			
	45	8.60	41.58	30.85
	40-45	1.50	1.60	2.10
	30-40	5.30	5.20	6.10
	25-30	4.30	3.40	4.00
	20-25	5.60	4.00	4.50
	15-20	6.90	4.60	5.50
	10-15	8.50	6.00	6.50
	8-10	4.10	3.20	3.20
	5-8	7.30	4.80	5.10
	3-5	5.70	3.00	4.10
	3	42.20	22.62	28.05
16.	DTA Endotheric peak temp. Exothermic peak	530^{o} C 980^{o} C	528^{o} C 985^{o} C	538^{o} C 982^{o} C
17.	Dominant mineral	Kaolinite	Kaolinite	Kaolinite
18.	Impurities	Quartz Muscovite	Quartz Muscovite & Pyrophyllite	Quartz Muscovite & Pyrophyllite

DEFLOCCULATION & SCRUBBING RESULT BY ORE-DRESSING LABORATORY, INDIAN BUREAU OF MINES, NAGPUR

Details of Tests	Clay Sample from Mamura Mines Dist. Kutch	Crude China clay Arsodia Mines Dist.Sabarkantha	Clay sample from Manfara Mines Dist.Kutch
Chemical Analysis of as received Sample	Assay %	Assay &	Assay %
Al2O3	18.91	19.30	13.03
SiO2	70.49	69.80	78.17
Fe2O3	0.58	0.50	0.53
TiO2	1.11	0.51	0.71
CaO	0.40	0.92	0.70
MgO	0.23	0.27	0.31
K2O	0.05	0.07	0.04
LOI	7.66	8.40	5.90
Scrubbing:			
a) Pulp Density	50% solids	40% solids	50% solids
b) RPM	800	1200	1000
c) Scrubbing Time	10 minutes	10 minutes	10 minutes
Product:			
+35 mesh	4.5	34.4	-
-35+100 mesh	38.2	7.5	54.7(+100#)
-100+200 mesh	14.5	3.2	9.6
-200+325 mesh	3.5	2.9	1.3
-325 mesh	39.3	52.0	34.4
Total	100.0	100.0	100.0
Chemical Analysis of -325 mesh	Assay %	Assay %	Assay %
Al2O3	38.87	38.85	33.95
SiO2	44.23	44.28	43.44
Fe2O3	0.66	0.41	0.96
TiO2	1.70	0.74	1.53
CaO	0.13	0.30	0.53
MgO	0.24	0.22	0.41
K2O	0.07	0.02	0.03
LOI	13.69	14.21	14.26
Wt. % Yield(-325#)	39.3	52.1	34.4
PSA(-2.4 micron)	48.8%	66.1%	52.5%
Deflocculation			
Optimised pH	10.1	9.5	
Sedimentation Rate	35 min/cm	10 min/cm	
Decant (-2.4 micron)	82.5%	81.8%	

ANNEXURE-X

LIST OF CHINA CLAY LEASE HOLDERS

Sr. No.	Name of Lease holders	Location of mines
Amreli		
1.	Shri Vasantrai Manilal Doshi Vavera, Via, Rajula, Amreli	Devaka
2.	Shri Pradeep Rashiklal Shukla Girapark Society, Vejalpur Road, Ahmedab	Rajula
3.	Shri Khodiyar Pottery Works Sihor, Bhavnagar	Rajula
Kachchh		
1.	Shri Vinod Purushottamdas Solanki Junavas, Madhapar, Tal. Bhuch, Kachchh Dist.	Nadapa
2.	Shri Vinod P Solanki	
3.	M/s Ghanshyam Minerals Makehl, Tal. Rapar, District Kachchh.	Ratnal
4.	Shri Vinod Purushottamdas Solanki Junavas, Madhapar, Tal. Bhuch, Dist. Kachchh	Nadapa
5.	Shri Vinod P Solanki	Nadapa
6.	Shri Rasiklal Bhimmji Doshi Meghdut Stores, K.T. Shah Road, Mandvi, Dist. Kachchh	Bela
7.	Shri Bharatkumar Manilal Patel Saraswati Chinaclay works, Bhuj, Dist. Kachchh.	Manfara
8.	Shri Vasantkumar Rambhai Patel Ladol, Tal. Vijapur, Dist. Mehsana	Mamuara
9.	M/s Ashish Mines & Minerals P B. No. 29, Mandavi, Dist. Kachchh.	Lodai
10.	Shri Raichand Korshi Nishar Gita Appartment, 6th floor, Flat No. 27, Gandevi Bombay - 400 027	Kakrava
11.	Shri Ramesh N. Shukla Ravalfaliya, Hadvad, Dist. Surendranagar	Mauara
12.	Shri Valji Jivandas Suraiyya C/o Kachchh Oil and Allied Ind. Pvt. Ltd. Mandavi, Dist. Kachchh.	Kakarva
13.	Shri Indubhai S. Jani Bander Road, Mandavi, Dist. Kachchh.	Kandarai
14.	Shri Shah & Pandya Minerals Enterprise, Bander Road, Mandvi, Dist. Kachchh.	Lifri
15.	M/s Shiv Minerals ukma, Tal. Bhuj, Dist. Kachchh.	Paddhar

1	2	3
16.	Westcoast Minerals & Chemicals District Panchmahal, 1. Shri I.B. Patel, Jaihind Society, Rambag, Maninagar, Ahmedabad	Dolathar, Bhammson Kammat
17.	Shri Harji Ramji Pandharia Mirsapm, Tal. Bhuj	Mamuara
18.	Shri Gopal Rupa Gangal Jowaharnagar, Ta. Bhuj	Modsar
19.	Smt. Kamshriban Shivraj Madhuda 997 Hinghalajwadi, Nr NCC Office, Bhuj	Padthar
20.	Shree Ram Mineche International Junavas, At Madhapar, Ta. Bhuj	Padthar
21.	Shri Hiralal Rana Patel At. Chammardi, Ta. Bhuj	Chamradi
22.	Smt Manjula A Ganada Plot No.18/4 Jadvajinagar College Road, Bhuj	Mamwora
23.	Shri PV Savla Kutch Minerals Pvt Ltd, Mandvi-Kutch	Manfara
24.	Shri Gangaram Samant Charda At. Anandpura, Ta. Bhachau	Jananpadar
25.	Shri Marji Punja Patel At. Wandh, Ta. Bhachau	Sulchpan
26.	Shri Ratilal Dharamsi Thakkar At. Fatehgadh, Ta. Rajpar, Dist. Kutch	Moda
27.	Shri Shankarlal Gangara Thakkar At. Santalpur, Dist. Banaskantha	Mamwora
28.	Shri Rameshbhai Mohanbhai Patel At. Ranjupm, Ta. Bajapur	Thaja
29.	Shri Jitendrakumar Shankarlal Jabanputra At. Santalapur, Dist. Banaskantha	Jaravada
30.	Shri Amichanbhai Shankarlal Patel 7, Jalaram Society, Radhapur Dist. Banaskantha	Fateghadh
31.	Shri Chetan Prabhudas Shah At. Kukuma, Ta. Bhuj	Ratnal
32.	Shri Dahyalal Arjan Manad At. Kukrima, Ta.aa Bhuj	Madsar
33.	Smt. Aruna V Suchdev Mainchem, 2-B Jadavjinagar, Bhuj	Mamuara
34.	Shri Gopal Sara Dagar At. Nadapa, Ta. Bhuj	Dagala
35.	Shri NV Shah Plot No.643, Sector-3, Gandhidham-Kutch	Mamuara

1	2	3
36.	Shri AS Kangal Plot No.34, Sector-2, Gandhidham-Kutch	Mamura
37.	Shri AS Mehta Plot No.43, Sector-43, Gandhidham-Kutch	Mamura
38.	Raichand Karshi Nisar Gita-A, 6th Floor, Flat No.27, Gandevi, Bombay-7	Kakara
39.	Shri Mahendrakumar Chatrabhuj Manani At. Anjar-Kutch	Sukhpur
40.	Shri Haresh Surendra Mehta Plot No.43, Sector-3, Gandhidham-Kutch	Mamuara
41.	Shri Nitin Vallabhbhai Shah Plot No.43, Sector-3, Gandhidham-Kutch	Mamuara
Banaskantha		
1.	Shri Gangaram Valjibhai Thakkar Santalpur, Via, Palanpur, Dist. Banaskantha.	Aluvas
Mehsana		
1.	M/s Oriental Prospecting Co. 1680/2, Opp. Desaipole, Sir Chinubhai Road, Khadia, Ahmedabad	Kot, Ramsipur Rampur, Pedhamli
2.	M/s Ambey India Pvt Ltd New Bhramkhalu Society, Paldi, Ahmedabad-7	Ransipur, Rampur
Sabarkantha		
1.	M/s Eklara Chinaclay Works 1105, Salvini pole, Jamalpur, Ahmedabad	Eklera
2.	Eklera Trading Co 8 Sampath Comm.Centre, 4th Floor, Op.Capital Comm. Centre, Ashra Road, Ahmmedabad-7	Eklera
3.	Shri Amidhar Chunilal Joshi Ami Minerals(India), Station Road, Himatnagar-383 001	Darad
4.	Shri Mahendrakumar Shantilal Kadiya 11/Maharashtra Society, Ahmedabad	Eklera
5.	Shri M.K. Rajensrasingh Daljitsingh Pratap palace, Himatnagar, Dist. Sabarkantha	Darad, Eklera
6.	Amrapali & Co. 289, New Cloth Market, Opp.Raipur Gate, Ahmedabad-2	Eklera
7.	Ishwarlal Ambalal Patel Eklara. Tal. Idar	Eklera

Source: Directorate of Geology & Mining, Block No.1, New Mental Bldg. Meghaninagar, Ahmedabad-3780 016.

IMPORTANT CHINA CLAY LEVIGATION PLANT OWNERS

1. Amrapali & Co.
   289 New Cloth Market, O/s Raiapur Gate
   Ahmmedabad-380 002
   Phone: 361253, 365851 Fax: 313175

2. Eklera China Clay Works
   8 Janpath Comm. Centre, 4th Floor
   Opp. Capital Comm. Centre
   Ashram Road, Ahmedabad-380 009
   Phone: 443343

3. Ashapura China Clay Works
   Jeevan Udyog Bldg., 3rd Floor, 278 DN Road
   Fort, Bombay-400 001
   Phone: 2880258 Fax: 022-2882395/2044452

4. HD Enterprises
   HD House, Silver Point, Station Road
   Kutch-Bhuj-370 001
   Phone:(02832)21972 Fax: 0283-21937

5. Shri Ram Minerals
   GIDC Area, Madhapur-370 020
   Kutch-Bhuch
   Phone: 22882

6. Kutch Minerals Pvt Ltd
   24/4 Sidhu Society, Nr Buddh Ashram
   Adipur-Kutch
   Phone: 02836-61293

7. Ami Minerals
   Station Road, Himatnagar-383 001
   Sabarkantha
   Phone:02772-22478

Source: iNDEXTb, Govt. of Gujarat Organisation.

LIST OF CHINACLAY CONSUMING INDUSTRIES

Sl. No. (1)	Name and address of company (2)	Specification (3)
	Abrasive	
1.	Carborundum Universal Ltd. 11/12, North Beach Road, P B No. 1677, Madras - 600 001.	Should be white burning and should not sinter at 1320°C Al_2O_3 - 40% max SiO_2 - 40% max Fe_2O_3 - 0.5% max
2.	Cutfast Bonded Abrasives Pvt Ltd. PO Pallikaranai, Madras - 600 073	-
3.	Hanuman Prasad Pragdas Chandra Shekhar Azad Marg, (Kotwali Road), Mirzapur Uttar Pradesh.	-
4.	Krishnalal Thirani & Co. Ltd. 1 & 3 Brabourne Road Calcutta-700 001	White hard lumps Al_2O_3 - 40% : SiO_2 - 45% CaO - 0.5% : MgO - 0.3% Na_2O - 4% : Fe_2O_3 - 0.8% L.O.I - 12.5% : Sp gr - 2.7
5.	Thermal Products Company Ganesh Wadi, Ganesh Bhavan, 2nd floor, Bombay - 400 002	Off white Water absorption-12.86% Al_2O_3 - 37.53% SiO_2 - 48.48%
	Asbestos Products	
1.	Asbestos & Jointings Mfg. Co. Pvt. Ltd. Parsi Panchayat Road, Andheri (East), Bombay-400 069	-
2.	Dutt Bros. & Company, 34, Netaji Subhas Road, Calcutta 700 001.	-
3.	Hindustan Ferodo Ltd. PB No. 9213, Ghatkopar, Bombay-400 086	-

1	2	3
4.	J.J. Jones & Co. Ltd C/5, Gillander House, 8, Netaji Subhash Road, P B No. 393 Calcutta 700 001.	Crude, conforming to rubber and textile grades
5.	Industries Pvt. Ltd 215, Neelam, 103, Seaface road, Worli, Bombay 400 018	Pottery grade
6.	Newkem Products Corporation, Lake Road Off Bombay-Agra road Bhandup, Bombay 400 078	-
7.	Reinz-Talbros Pvt. Ltd 205/94, Meghdoot, Nehru place, New Delhi 110 024	Commercial & industrial grade

Battery

1.	Bharat Battery Mfg. Co.(Pvt) Ltd. 238, Acharya Jagadish Chandra Bose Road, Calcutta 700 020	Size: 200 mesh Sugar - 2.6 L.O.I - 13% Fe - 0.05% Cu - 0.01% max Mn - 0.01%
2.	Chloride India Ltd. Exide House, 59, E, Chowringher Road Calcutta 700 020	Size:120 mesh
3.	Mysore Electro-Chemical Works Ltd. Yeshwantpur Bangalore-560 022	-
4.	Travancore Cements Ltd., Kattakora, Kottayam 636 013 Kerala	Raw white clay Clay content-30% Fe_2O_3-less than 1% Al_2O_3 to Fe_2O_3- Not less than 30

Ceramic & Refractory (Ceramic)

1.	Baroda Potteries Ltd, Industrial Area, Pratapnagar Baroda 390 004 Gujarat	-
2.	Bawa Potteries, 6, Haidley Road, New Delhi	-
3.	Bengal Potteries Ltd., Thapar House, 25, Brabourne Road, GPO Box. No. 2196 Calcutta 700 001.	Washed clay Size:200 mesh
4.	Bihar Industrial Corporation, 34, Delhi Serampore Road, Calcutta 700 014	SiO_2 -47.1% Al_2O_3 -38.1% Fe_2O_3 -1.7% MgO & TiO_2 -Traces CaO -0.6% Alkalies -0.5% L.O.I -11.9%
5.	Central Glass Industries (P) Ltd 7, Swallow Lane, Calcutta 700 001.	-
6.	Central Potteries Ltd., Bagadganj, Nagpur -440 008 Maharashtra.	-
7.	Ceramic Products Ltd., Nr. Rly. Stn. Khanpur, Dist. Belgaum, Karnataka	Good Plastic with low P..C.E Al_2O_3 -26% SiO_2 -60-70%
8.	Commonwealth Tile Factory, PB No. 5, Calicut 673 001 Kerala	Plastic, Sand content-5-10%
9.	Deccan Porcelain & Enamel Works Ltd. 2707 , New Bakaram, Gandhinagar Hyderabad 500 080, Andhra Pradesh	-
10.	Eastern Ceramics Ltd., Mahatma Gandhi Rd., Goregaon (West), PB No. 7511 Bombay 400 062	Washed lumps

1	2	3
11.	E.I.D Parry Ltd., "Dare House" P B No.s 12, Madras 600 001	White burning, smooth textured. Less plastic — Plastic SiO_2-45-48% — 50-58% Al_2O_3-34-38% — 20-25% Fe_2O_3-1.0% — 5-10% L.O.I-13-14% — 7-10% Plastic clay is yellow in colour, fired coloure is brick-red.
12.	Ferro Coatings & Colours Ltd., PO Joka, 24, Parganas, West Bengal	-
13.	Fordham Pressings (India) P. Ltd. Nanathay Mansion, Sir P.M. Road, Bombay 400 001	Size: 200 mesh Plastic; Iron content should be less Purity-99.9%
14.	Govt. Ceramic Factory, Gudur, Dist: Nellore Andhra Pradesh	-
15.	Gwalior Potteries (M.P State Industrial Corpn.), Potteries Road, PB No. 18, Gwalior, Madhya pradesh	Highly Plastic clay Al_2O_3-39.9% SiO_2-41.3% P.C.E-21
16.	High Tension Insulation Factory, (Bihar State Industrial Development Corpn. Ltd) Bandar Bagicha, Patna 800 001 Bihar	Green-bonding strength - Abot 5-10 kg/cm^2 and 40 kg/cm^2 (for two varieties of clays respectively) Clay content-about 96% & 92% Iron content - less than 1.5% 0.5%, respectively, for the two varieties of clays.
17.	Hindustan Sanitaryware & Industries Ltd., 2, Wellesley Place, Calcutta 700 001	Size: 200 Mesh SiO_2 -47-49% Al_2O_3 -38-40% CaO -0.7-1.0% max $Fe_2O_3 + TiO_2$-0.5% max Fired colour at 1200° C - Off white to white.
18.	H & R Higbsib (India) Ltd., Nanabhoy Mansion, Sir P.M. Road, Bombay 400 001.	Size: 200 mesh Fired colour - white Al_2O_3-30% min Fe + Ti-1% max oxides

1	2	3
19.	Jayashree Insulators, Veraval Junagarh Road, Veraval, Gujarat.	Size : 300 mesh Grit -0.5% SiO_2 -46.4 to 47.8% Al_2O_3 -36.5 to 37.1% Fe_2O_3 -0.68 to 2.0% L.O.I -12.7 to 13.50%
20.	Kathiawar Industries Ltd., PO Sherbaug - 362 255 Gujarat	-
21.	Kerala Ceramics Ltd., Kundara - 691 501 Dist: Quilon, Kerala	White lumpy with high plasticity
22.	Khodiyar Pottery Works Ltd., Sihor, Dist: Bhavnagar Gujarat	SiO_2-44.20% Al_2O_3-38.85% Fe+Ti oxides-1.37% CaO + MgO-1.16% L.O.I-14.42%
23.	Mysore Porcelains Ltd., PB No. 1245 Bangalore 560 012 Karnataka	Free from red ochre Size: 10 microns & less Fe_2O_3-0.15 to 1.25%
24.	Navbharat Potteries P. Ltd. Tokershi Jivraj Wadi, Zakaria Bundel Road, Sweri (West) Bombay - 400 015	Pottery grade
25.	Nyevelli Ceramics & Refractories Ltd., PO Vadalur - 607 303 Dist: South Arcot, Tamil Nadu	White burning plastic clay
26.	Parshuram Pottery Works Co. Ltd., Morvi, Gujarat	SiO_2-46.50% Al_2O_3-37.40% $Fe_2O_3$0.30% TiO_2-0.75% MgO-0.50% CaO-0.55% L.O.I-1%
27.	Promudgoss & Co. Pottery works 30/1, Agarwalla Garden Rd. Calcutta 700 038	-
28.	Rajaniklal Ceramic P. Ltd., 10, Portuguese Church St., PB No. 931 Calcutta 700 001	-

1 2	3
29. Sashasayee Industries Ltd., Vadalur 607 303 Dist. South Arcot Tamil Nadu	White burning clay Alumina-35-38%
30. Sodepore Potteries P. Ltd., PO: Sodepore Dist: 24-Paraganas, West Bengal	-
31. Somany - Pilkington's Ltd., Koasar-124 5507 Dist: Rohtak Haryana	Beneficiated clay, should have low content of iron, titania & lime as impurities
32. South Arcot Electricals & Ceramics P. Ltd., Industrial Estate Thattanchavaci Pondicherry 605 009	SiO_2-46.5% Fe_2O_3-1% max
33. Sur Enamel & Stamping Works P. Ltd., 24, Dr. L.M Bhattacharjee Rd., (Old-24, Middle road Entally) Calcutta 700 014	Powder Combined SiO_2-45.35% Free SiO_2 -2.05% Al_2O_3 -34.94% Fe_2O_3 -1.28% CaO -0.61% MgO -0.81% K_2O -2.94% Na_2O -0.54% L.O.I -11.25%
34. Sur Industries P. Ltd. 163, Acharyya Jagadish Bose Rd. Calcutta 700 014	-
35. Tamil nadu Ceramics Ltd., 20, Conataph Rd., Teynampet Madras 600 018	-
36. U.P Ceramics 7 Potteries Ltd., 'Vandhna', 11th floor 1. Tolstoy Marg New Delhi 110 001	White, plastic SiO_2-55% Al_2O_3-42%
37. L.S Insulators of India Ltd. 'Dhun Building', 175/1, Mount Road, Madras 600 002	White fired clay SiO_2-44-45% Al_2O_3-39-40% Fe_2O_3-0.7% max TiO_2 CaO MgO-0.5% max L.O.I-13.5-14%

1	2	3

Ceramic & Refractory

1.	Bombay Potteries & Tiles Ltd., United India Building, Sir P.M road, Fort Bombay 400 001	Lumps, white burning SiO_2-45-48% Al_2O_3-35-40% Free from iron
2.	Durga Enterprises P. Ltd., Po Malaknagar Ghaziabad Uttar pradesh	No free quartz Al_2O_3 SiO_2-68% L.O.I-8%
3.	Hindusthan Potteries 12, Shib Kristo Daw Lane, Calcutta 700 007	As per I.S specification
4.	New India Ceramics Ltd., Feroka, Cheruvannur, Dist: Calicut, Kerala	Iron Oxide-0.5% max SiO_2-44-45% Al_2O_3-39-40%
5.	Orissa Industries Ltd., PO Barang, Dist: Cuttack Orissa.	SiO_2-64.37% Al_2O_3-27.26% L.O.I-rest
6.	Parshuram Pottery Works Co. Ltd. Morvi, Dist: Rajkot, Gujarat	High alumina clay Al_2O_3-46% Fe_2O_3-2% max **Plastic** SiO_2 -43.85% Al_2O_3 -1.23% TiO_2 -1.10% CaO -0.50% L.O.I -12.60%
7.	Pennar Potteries Vaviletipadu Dist: nellore, Andhra Pradesh	White fired clay SiO_2-44-45% Al_2O_3-39-40%
8.	Quilon Ceramics PB No. 14, Quilon-691 001. Kerala.	SiO_2-44-46% Al_2O_3-38-40% Fe_2O_3-1% max.
9.	Stoneware Pipes (Madras) Ltd. Trivellore R.S. Dist. Chingleput Tamil Nadu.	SiO_2-63.22% Al_2O_3-22.97%TiO_2-1.92% CaO-0.96% L.O.I-11.51%

Refractory

1.	A.C.C. Limited Cement House, 121, Maharshi Karva Road., Bombay 400 020	P.C.E-31 Al_2O_3-30-31% Fe_2O_3-3.5% max CaO-0.5% max
2.	Belpanar Refractories Ltd., PO Belaphar, Dist: Sambalpur, Orissa.	Al_2O_3-30% min Fe_2O_3- 1.5% max
3.	Bharat Refractories Ltd., (Subsidiary of Bokaro Steel Ltd) PB No.1, Bokaro Steel City-827 001 Dhanbad, Bihar	After pulverising and subsequent firing should not give from spots. P.C.E-1550°C min 1600°C max Al_2O_3-16% min 20% max Fe_2O_3-2% max L.O.I-6% max
4.	Bhupal Mining Works Bhilwara Dist: Bhilwara, Rajasthan.	SiO_2-43.6% Al_2O_3-37.9% Fe_2O_3-0.9% TiO_2-2.2% MgO-0.7% Na_2O+K_2O-0.9% L.O.I-13.4%
5.	Burn Standard Company Ltd. 10-C Hungerford Street, Calcutta 700 017	P.C.E-30 Orton cone Al_2O_3-32% min Fe_2O_3-1.5% max L.O.I-10% P.C.E-33 to 34 Orton cone Al_2O_3-48-50% SiO_2-26-28% Fe_2O_3-1.5% max L.O.I-18-20% TiO_2 & CaO- In traces
6.	Haryana Refractories Pvt. Ltd. 17, Ganesh Chandra Avenue Calcutta 700 013	P.C.E-31 Al_2O_3-30% Fe_2O_3-1.5% max
7.	Hind Refractories Ltd. 135, Biplabi Rash Behari basu Road, Calcutta 700 001	P.C.E.-32 to 33 SiO_2-48.30% Al_2O_3-34.28% Fe_2O_3-2.53% TiO_2-2.20%
8.	Hindusthan Refractories & Ceramics Pvt. Ltd. 20, Netaji Subhash Road Calcutta 700 0	Sp.gr-1.78 P.C.E.-32 to 33 SiO_2-47.30% Al_2O_3-38.70% Fe_2O_3-1.5% TiO_2-2.2% L.O.I-10.33%

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9.	India Firebricks & Insulation Co. Ltd. Nirmal Building, 21st floor, Nariman Point Bombay 400 021	Washed clay, textile grade Al_2O_3-37% Fe_2O_3-2%
10.	India Refractories, 9/1, R.N. Mukherjee road, Calcutta 700 001	Al_2O_3-16-20% Fe_2O_3-2% max L.O.I-6%
11.	Jauhar Firebricks & Refractory Works Private Ltd. New Delhi.	-
12.	Kharkharee Firebricks Works Room No.91 (5th floor) Stephen House, Dalhousie Square East, Calcutta 700 001	Al_2O_3-38%
13.	Kumardhubi Fireclay & Silica Works Ltd. Chartered Bank Building Calcutta 700 001	P.C.E-30-31 orton cone Al_2O_3-33% min Fe_2O_3-2% max L.O.I-13% max
14.	Maithan Ceramic Private Ltd. 36/2, Vivekananda Road Calcutta 700 007	-
15.	Mysore Iron & Steel Ltd., Bhadravati-577 301 Dist: Shimoga Karnataka	Lumps SiO_2-45-60% Al_2O_3-30.40% Fe_2O_3-3.5% max Alkalies-1% max L.O.I-8-10%
16.	Orissa Cement Ltd. Rajgangpur 770 017 Dist: Sundergarh Orissa	Good plastic & dense in firing Al_2O_3-32% min Fe_2O_3-2% max TiO_2-1% max
17.	Orissa Industries Ltd., Katchery Road, Rourkela 769 001 Orissa	P.C.E-18 orton cone SiO_2-64-65% Al_2O_3-22-24% Fe_2O_3-1% Alkalies-1.5-2% L.O.I-8%
18.	Valley Refractories Pvt. Ltd 40-B, Vivekananda Road, Haryana Niwas(1st floor) Calcutta 700 007	Plastic clay P.C.E-30-33 orton cone SiO_2-45.6 to 58% Al_2O_3-29.2 to 36.6% Fe_2O_3-1.4 to 2.6% Alkalies-0.7 to 1.0% L.O.I-9.1 to 13.3

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19.	VRW Refractoreis (Unit of Tube Suppliers Ltd.) 36-40, Armenian Street, Madras 600 001	-

Chemical

1.	Alkali and Chemical Corpn. of Ind. Ltd. 34, Chowringhee Road, Calcutta 700 016	Lumps & Powder Oil Absorption-28 -30% L.O.I. 105°C-4% max Slightly off white powder Size: 240 B.S mesh
2.	Calico Mills, Calico Chemicals Plastics & Fibres Division Outside Jamalpur Gate Ahmedabad 380 022 Gujarat	-
3.	Indian Explosives Ltd., 34, Chowringhee Road, Calicutta 700 016	-
4.	Minerals & Chemical Products PO Chaibasa 833 201 PB No. 21 Dist: Singhbhum Bihar	-

Cosmetic

1.	Bengal Chemical & Pharmaceutical Works Ltd. 6, ganesh Chandra Avenue Calcutta 700 013	Powder I.P Standard
2.	Duphar Interfran Ltd., F/5, Shivsagar Estate, Dr. Annie Besant road Bombay 400 018	Indian Pharmaceutical (IP) Standard
3.	Godrej Soaps Pvt. Ltd Eastern Express Highway, Vikhroli Bombay 400 079	As per I.S specifications (cosmetic grade)
4.	Lakme Ltd., Bombay House, 24, Hani Mody Street Bombay 400 001	-do-

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5.	Muller & Phipps (India)Ltd. Queen's Mansions, Amrit Keshav Naik Marg, PB No. 773 Bombay 400 001	Kaolin

Electrical

1.	Asian Cables Corporation Ltd. 'Nirmal' 241-242, Backbay Reclamation, Nariman Point, Bombay 400 021	-
2.	Asian electronics Ltd Handloom House, 3rd floor 221, Dr. D.N. Road, PB No. 1863 Bombay 400 001	Lumps
3.	Cable Corporation of India Ltd Laxmi Building 6, Shoorji vallabhdas Marg, Bombay 400 038	Size: 30 to 44 micron Al_2O_3-40-45% SiO_2-40-45% L.O.I-12-15% at 900 ^{o}C Moisture-0.9% max
4.	Devidayal Electronics & Wires Ltd., Gupta Mills Estate Daru Khana Reay Road Bombay 400 010	Powder Size: 200 mesh L.O.I on dry sample-13+-1.5% Moisture-1% max.
5.	Fort Gloster Industries Ltd., (Cable Division) 21, Strand Road, Calcutta-700 001	Size: 200 mesh Moisutre-3% max MnO_2-0.03% max CuO-0.005% max L.O.I-12-14%
6.	Indian Cable Company Ltd., 9, Hare Street Calcutta 700 001	I.S Specification
7.	Mahendra Electricals Ltd., Kamala Mission Road, Nadiad, PO B No. 43 Dist: Kaira, Gujarat	Rubber grade
8.	National Insulated Cable Company of India Ltd. 'Nicco House' Hare Street Calcutta 700 001	Size: 200 mesh Moisture-1.0% max water solubles-0.1% max L.O.I-13 +-1.5% Mn oxide-0.01% max Co oxide-0.01% max
9.	Universal Cables Ltd. PO Birla colony Satne, Madhya Pradesh	-

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Electrodes

1.	Ahura Welding Electrode Mfg. Ltd. 35, Ramchandra Road, R.S Puram Coimbatore 641 002 Tamil Nadu	Powder Al_2O_3-30% K_2O-4% min S & P - 0.001% max
2.	Apar Private Ltd. (Formerly Power Cables Pvt. Ltd) Opp. 'D' Cabin, Chhani road, Baroda 390 002 Gujarat	Powder SiO_2-45%
3.	D & H Secheron Electrodes Pvt. Ltd. 44/46, Industrial Estate, Fort, PO B 69 Indore 452 004 Madhya Pradesh	-
4.	Eutectic Welding Alloys of India Ltd. L & T House, Ballard Estate, Bombay 400 038	Size: 350 mesh SiO_2-65% Al_2O_3-20%
5.	General Electrodes & Equipment Ltd., Jiji House, Haveline Street, Bombay 400 001	Size: 230 mesh SiO_2-50% Al_2O_3-30-32% P-0.07% max S-0.025% max
6.	Phillips India Ltd., 7, Justice Chandra Madhab Road, Calcutta 700 020	SiO_2-40-50% Al_2O_3-30-35% S-less than 0.03% L.O.I- 12-15%
7.	Rockweld Electrodes India Ltd., 29, Industrial Estate Ambattur, Madras 600 058	SiO_2-50% Al_2O_3-35%
8.	Welding Rods Manufacturing Co. PB No. 20, Industrial Estate, Udhna, Surat Gujarat.	SiO_2-46.5% Al_2O_3-39.5% L.O.I-14.0%

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Fertilizer

1.	Andhra Fertilizers (P) Ltd., Dare House, PO Box No. 12 Madras 600 001	-
2.	Madras Fertilizers Ltd., Manali, Madras 600 068	Size: 325 mesh Moisture-Less than 1% Free silica-1% max Acid soluble Fe & Al oxides-4% max

Foundry

1.	Hindustan Motors Ltd. 9/1, R.N. Mukherjee road Calcutta 700 001	As I.S specification No. IS 2840-1965
2.	Hindusthan Malleables & Forgins Ltd., Jalan Nagar, PO Bhuli, Dist. Dhanbad, Bihar	-do-

Glass

1.	Central Glass Industries P. Ltd. 7, Swallow Lane Calcutta 700 001	-
2.	Fibreglass Pilkington Ltd., 9, Wallace Street Bombay 400 001	-

Insecticide/Pesticide

1.	Bangalore Pesticide ltd. 7/4, Sankey Road, Bangalore 560 020 Karnataka	Powder
2.	Bayer (India) Ltd., Express Towers, Nariman Point, Bombay 400 021	Size: 400 mesh Bulk density-0.5 gm/cc H_2O-0.5% max
3.	Bharat Minerals & Chemicals Co. 174, Mahatma Gandhi Road, Calcutta 700 007	-

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4.	Hindustan Insecticides Ltd., C-255, Defence Colony, New Delhi 110 003	Soft washed lumps, creamy & white. Wettability-within a minute Compact sedimentation- within 30 minutes Carbonates - Nil pH-7.0 - 7.00 Bulk density-0.56 gm/cc Moisture-Les than 1.0% White coloured powder Size: 200 mesh: Grit-0.5% max Moisture-1.5% max: Bulk density - 0.8 gm/cc Wettability- Quick: Carbonates - Nil Iron as Fe-0.35% max water soluble matter - 0.5% max pH - 6.0-8.0
5.	Jaipal Udyog, 302, Akash Deep, Barakhamba Road, New Delhi 100 001	Grit-free off coloured clay with good suspending quality
6.	Jayalakshmi Fertilizers (Pesticide Division), Venkatarayapuram, PB No. 5, Tanuku, Dist: West Godavari, Andhra Pradesh	Lumps, free from moisture, iron, etc.
7.	National Pesticides, 5, Industrial Estate, Vidisha, Madhya Pradesh	White and cream coloured lumps
8.	Penta Chem, Plot No. 20/23 Industrial Estate, Kadgaon, Ahmednagar 414 001 Maharashtra	-
9.	Pesticides India PB No. 20 Udaipur 313 001 Rajasthan	Disintegrated lumps Whiteness-78% SiO_2-40-50% Al_2O_3-20-40% Fe_2O_3-0.3-0.7%
10.	Rallies India Ltd., Ralli House, 21, Ravelin Street, Fort, Bombay 400 001	Soft lumps, free from girt Moisture-0.5% Soft, off white lumps SiO_2-43.08%: Al_2O_3-37.92% CaO-0.54%: Fe_2O_3-2.1% TiO_2-2.4%: MgO-Traces
11.	Sandoz (India) Ltd., Sandoz House, Dr. Annie Besant Road, Worli, Bombay 400 018	White lumps, Carbonates-0.5% Moisture-3%

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12.	Scientific Insecticides Co., 13/14, Second Line Beach Madras 600 001	Levigated china clay Grit-0.3% pH-6-8
13.	Singhal Pesticides, 9/122 Moti Bagh, Agra-280 006 Uttar Pradesh	White powder, suspensibility-55% min pH-neutral to slightly acidic but not less than 6.
14.	SMP Pvt. Ltd. Subhash Road Jogeswari East, Bombay 400 060	White to off-white. Good plastic with high fusion point.
15.	Tarapur Chemicals & Pesticides, E-47, Tarapur Industrial Area Boiser-401 501 Thana, Maharashtra	Levigated lumps
16.	Travancore chemical & Manufacturing Company Ltd., Kalamassery Alwaye, Dist: Ernakulam, Kerala	White & yellow soft lumps.
17.	Union Carbide India Ltd., 1, Middleton Street Calcutta 700 016	Levigated clay, Grit-1% max pH-6-7.5
18.	Union Pesticides, Shri Ram Nagar Vidisha, Madhya Pradesh	-
19.	United Pulverisers, Bodla, Agra 282 007 Uttar Pradesh	Powder Neutral to acidic
20.	Yawalkar Pesticides Pvt. Ltd. 52, Bajaj Nagar Nagpur 440 010 Maharashtra	Yellow Clay: Light yellow coloured inert sticky clay White clay: Greyish white coloured inert non-sticky clay

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		Paint
1.	Alkali & chmemical Corporation of India Ltd., 34, Chowringhee Road, Calcutta 700 016	Dry powder water solubles-0.5% max
2.	Amar Paints & Allied Industries, M.M Industrial Estate Yediyur, Bangalore 580 011 Karnataka	Size: 300 mesh
3.	Asia Chemicals Ltd., 3, Cast Park Road Karol Bagh, New Delhi 110 005	-
4.	Asean Paints and Chemical Works Tinukie, Dist: Dibrugarh Assam.	-
5.	Bangalore Enamels, Paints & Chemicals Ltd., XI-Main Road Malleshwaram, Bangalore-560 003 Karnataka.	Size:200 to 300 mesh
6.	Beco Chemicals, Thapar House, 25, Brabourne road Calcutta 700 001	-
7.	Bharat Varnish Manufacturing Co. Lal bahadur Shastri Marg, Ghatkopar, Bombay 400 086	-
8.	Blundell Eomite Paints Ltd., Rustom Building, 29, Veer nariman Road, PB No. 663 Bombay 400 001	As per I.S specification. Dry powder Volatile matter-2% max Carbonates-1% max Water solubles-1% max
9.	Bombay Paints & Allied Products Ltd. Corrider road, Gavanpada, Chembur, Bombay 400 074	As per I.S specification.
10.	British Paints 32, Chowringhee Rd., Calcutta 700 071	-do-

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11.	Chemi Chrome Industries(P) Ltd 84/79, G.T. road, Kanpur 208 003 Uttar Pradesh	-
12.	Comet Paints Ltd. Anand-Sojitra Road, Vallabh Vidyanagar 388 120 Dist: Kaira, Gujarat	Suitable for paint industry.
13.	Commercial Paint & Chemical Works, 48-C, Laxmibai Nagar Industrial Estate, Fort, Indore-452 002 Madhya Pradesh	-
14.	East India Paint & Chemical Works Ltd., 21, Gopal Chandra Bose Lane, Calcutta 700 050	-
15.	Elphinstone Paint & Colour Mfg. Company 50, Elphinstone road, Bombay 400 013	Paint grade
16.	Emperol Paints Pvt. Ltd. 5, Kustia road Calcuta 700 039	As per I.S specification.
17.	Eadee Paints Kolshat Road, Thane 400 607 Maharashtra	-
18.	Goodless Nerolac Paints Ltd. PO B No. 699 Ferbee Building, Charanjit Rai marg, Fort, Bombay 400 001.	-
19.	Goodluck Oil & Paint Co., Khanderao Road PB No. 120 Opp: Jawahar Society, Baroda 390 001 Gujarat.	-
20.	C.S Enterprises, A/9/1, R.I.C. Industrial Estate Bonhooghly Calcutta 700 035	-

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21.	Nardoastle & Waud Mfg. Co. Ltd., Brabouins Stadium, 87, Veer Nariman Road Bombay 400 020.	Size: 300 mesh
22.	Hyderabad Oil & Paint Co. Ltd., 2-3-61, Amberpet Industrial Area Hyderabad-500 013. Andhra Pradesh	Amorphous/powder
23.	India Paint Colour & Varnish Company Ltd., 14, Netaji Subhas Road Calcutta 700 01	Powder
24.	Industrial Coating corporation T.K. Industrial Estate Sewrea, Bombay 400 015	-
25.	Jenson & Nocholson (India) Ltd., 225, Acharya D.C. Bose Rd., Calcutta 700 020.	As per I.S Specification.
26.	Jyoti Oil & Paint Co. L.T. Road Borivli (West) Bombay 400 092	-
27.	Lakshmi Paint Works, 14/2 Old China Bazar Street, PO Box 2574, Calcutta 700 001	White powder & lumps
28.	Macferlane Paints, Industry House, 159, Churchgate Reclamation, Bombay 400 020	As per I.S specification
29.	Midland Industries 47, Crest Haq road Baquor 440 003, Maharashtra	-
30.	Modi Paint & Varnish Works, Kodinagar Dist: Meerut Uttar Pradesh	As per I.S specification
31.	Muruka Paint & Varnish Works P. Ltd. 48, Dalhousie Square, 29, Stephen House, Calcutta 700 001.	Powder.

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32.	Mysore Lao & Paint Works Ltd. PB No. 82 Mysore-570 001.	Powder, paint grad
33.	Nagrath Paints Pvt. Ltd. 2, Tolstory Marg, New Delhi	As per I.S specification.
34.	Noble Paint & Varnish Co. Pvt. Ltd. Forqueson Road, Lower Parel, Bombay 400 013	-
35.	P C Chanda & Co. (P) Ltd., Budge Budge Road, Calcutta 700 060	-
36.	Premier Paint 123/435, Fazalganj Kanpur, Uttar Pradesh	-
37.	Punjab-Paint Colour & Varnish Works, 123/529, Fazalganj Kanpur 208 012 Uttar Pradesh	Washed, textile grade.
38.	Ravi Paints & Chemicals Ltd., PB No. 5050 85/87, Armenian Street Madras 600 001	As per I.S specification.
39.	R.R Paints Pvt. Ltd., Bhandup, Bombay 400 078	-
40.	Savlar Paint & Varnish Works P. Ltd., Vihar Lake Road, Saki Naka Bombay 400 072	Paint grade (as per I.S specification)
41.	Seth Chemical Works, 160, Jamunalal bajaj Street Calcutta 700 007	Off colour, Al_2O_3-37.5% SiO_2-47.5%
42.	Shalimar Paints Ltd., 13, Comma Street, Calcutta 700 017	Size: 240 mesh Textile quality and off colour.
43.	Shekhar & Co. P. Ltd. 159, B.K. Paul Avenue Calcutta 700 005	-

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44.	Sigma Paints Ltd. 221, Dr. D.K Road Bombay 400 001	As per I.S specification I.S 68
45.	Titan Paint & VArnish Co. Ltd Pollachi Road Podawar, Coimbator 641 023 Tamil Nadu	-
46.	Ultramarine Pigments Ltd., Baldoka Bhavan 117, M. Karve Road Bombay 400 020	-

Paper

1.	Ballarpur Paper & Straw Board Mills Ltd., Ballarpur Dist: Chandrapur Maharashtra	Size: 200 mesh Moisture-1.5% max Fineness-65% Grit over 200 mesh-1% max Brightness-72%
2.	Ballarpur Paper & Straw Board Mills Ltd., Ballarpur, Dist: chandrapur, Maharashtra	Size: 200 mesh Moisutre-1.5% max fineness-65% min Grit over 200 mesh: 1% max Brightness-72%
3.	Bengal Paper Mill Co. Ltd., 14, Netaji Subhas Road, Calcutta 700 001	Powder High brightness with good plasticity Grit content-1% max L.O.I-14%
4.	India Paper Pulp Company Ltd. 8, Clive Row, Calcutta 700 001	Fine powder Brightness-85°CF Grit-1.5% Moisture-3% pH-7.5
5.	Mysore Paper Mills Ltd., PB No. 609 Bangalore 560 006 Karnataka	As per I.S specification brightness-80% Moisture-5% Grit-0.2%
6.	Paper Products Ltd., 13/14, Ajmeri Gate Extn. New Delhi	Soze: 180 mesh
7.	Premier Paper Mills Ltd., Vaswani Mansions, 120, Dinahaw Vacha Road, Bombay 400 020	-do-

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8.	Punalur Paper Mills Ltd., Punalur, Dist: Quilon. Kerala	Size:200 mesh Moisture 1% max pH-7.5 Grit less than -0.5%
9.	Rohtae Industries Ltd., Dalmianagar Dist: Rohtak Bihar	Size: 300 mesh brightness-89-90% pH-5.0
10.	Seshasayee Paper & Board Ltd. Pallipalayam Cauvery Rs.S., Dist: Salem Tamil Nadu.	Size: 200 mesh Brightness-75%min CaO-less than 0.5% Grit-less than 0.1% Fe_2O_3-0.7% max.
11.	Sirpur Paper Mills Ltd. Lingawar House, 3-6-237, Himayatnagar Rd., Hyderabad, Andhra Pradesh	Brightness-75-85%
12.	Straw Products Ltd. (J.K Paper Mills) Jaykeypur, Rayagada, Dist: Keraput, Orissa.	Powder, free from foreign matters, good plastic with good brightness.(85-90%) Moisture-3% max L.O.I.-10% max Fe_2O_3-0.5% max CaO-0.2% max
13.	Sun Coated Paper Company Block-D, Shivsagar Estate Dr. Annie Besant Rd., Worli Bombay 400 018	Size: 2 micorn SiO_2-46.2% Al_2o_3-38.0% Fe_2o_3-0.5% L.O.I-13.9%
14.	Titaghur Paper Mills Co. Ltd., Chatered Bank Buildings, Calcutta 700 001	Grit-1% max Moisture5%
15,	Titaghur Paper Mills Co. Ltd., Chartered Bank Buildings, Calcutta 700 001	-
16.	Trident Tissues Ltd., 3, Middleton Street, Calcutta 700 071	Suitable for paper industry-free from foreign matters.
17.	West Coast Paper Mills Ltd., Dundeli, Dist: North Kanara Karnataka.	-

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Rubber

1.	Akron Rubber Industries 134, Dhirubhai Parikh Marg Kalbadevi road, Bombay 400 002	Commercial grade
2.	Aliga Rubber Works 84/8, Fazalganj Kanpur, Uttar Pradesh	Powder Size: 250 mesh
3.	Apollo Tyres Ltd., Jos Annexe, M.G Road, Cochin 682 016 Kerala	Cream to buff coloured powder Size:200 to 325 mesh pH-4.5 to 5.5 sp-gr-2.5 +0.02
4.	Arvico Rubber Industries Palghar, Dist: Thane Maharashtra,	-
5.	Asha Rubber Industries L.B Shastri Marg Mulund, Bombay 400 080	Fine powder, free from metallic salts
6.	Associated Rubber Industries Ltd., Union Bank Building, 4th floor, Apollo Street, Bombay 400 001	-
7.	Baroda Rubber Industries Pvt. ltd., Vijaya Industrial Estate, Padra Road, PO Samiala Baroda 390 010 Gujarat	-
8.	Bata India ltd., 30, Shakespere Sarani Calcutta 700 017	Powder Moisture-1.5% pH-4.5 to 6%
9.	Bedrock Tyre & Rubber Company 16, Homi Mody Street Masjid Manor Fort, Bombay 400 023	Size: 350 mesh free fro carbonate pH-7
10.	Bengal Waterproof Works Ltd 41, Shakespeare Sarani Calcutta-700 017	Size: 250 mesh Moisture-2.5% max Water solubles-0.1% max pH-5-7 : Ca-0.1% max Mn-0.1% max : Fa-1% max L.O.I-10-15% max

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11.	Bharat Rubber Regenerating Co. Ltd., 4, Middleton Street Calcutta 700 071	-
12.	Bhor Industries Ltd., Sir Vitaldas Chambers, 16, Bombay Samaohar Marg, Bombay 400 001	Rubber grade
13.	Bombay Rubber Works Private Ltd., Saki Vihar Road, Bombay 400 072	Fine powder
14.	Canara Rubber Works P. Ltd. Mahabaleshwar, Kadri Rd., PB No. 732 Mangalore-575 003 Dist: South Kanara Karnataka	As per I.S specification
15.	Carona Sahu Co. Ltd., 221, Dr. Dadabhoy Naoroji Road Bombay 400 001	Size: 300 mesh, free from moisture.
16.	Cest Tyres of India Ltd. 463, Dr. Annie Besant Rd., Bombay 400 025	Size; 200 & 325 mesh Purity-99.5 to 99.9%
17.	Caomao India Rubber Works P. Ltd., Pb No. 107 7, Homji Street, Fort, Bombay 400 001	Size: More than 200 mesh Sp-gr-2.6 Acid insolubles-95% min No carbonates Moisture-1% max Ca-nil Mg-0.004% Al_2O_3-30% min L.O.I. 11-14%
18.	Dinesh Rubber Industries, Rustom Mills Compound, Dudheswar Rd., PB No. 288 Ahmedabad 380 001	-
19.	Dunlop India Lt., Dunlop House, 57-B, irza Ghalib Street Calcutta 700 016	Rubber grade

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20.	Eagle Rubber Industries, Ghatkopar Industrial Estate, Unit No. 13 A, B-Block, L.B Shastri Marg, Ghatkopar Bombay 400 086	-
21.	Enkay (India) Rubber Company Pvt. Ltd., 2/8, Roop Nagar, Delhi-110 007	-
22.	Firestone Tyre & Rubber Company of India Pvt. Ltd. Hay Bunder Rd., Bombay 400 001	Size: 325 mesh Al_2O_3-36 to 41% SiO_2-41-46% L.O.I-13 to 14.5% Moisture-1.25% max
23.	Fort Gloster Industries Lte., 21, Strand Rd., Calcutta 700 001	Size: 200 mesh Water solubles-0.2% mmax CuO-0.005% max Mn_2O_3-0.03% max L.O.I-12 to 14%
24.	Goodyear India Ltd., 60, Chowringhee Rd., Calcutta 700 020	Off-white, light cream to pink powder Size: 325 mmesh Moisture-1% max pH-4. to 5.5 L.O.I-15% max
25.	Gujarat Rubber Works Ltd., Pratapnagar, Baroda 390 004 Gujarat	Rubber grade Size: 300 mesh Sp-gr-2.50 to 2.60 Free fro carbonates Silica content-65%
26.	Milton Rubber Pvt. Ltd., 209, Aneel Bhavan, Kasturba Gandhi Marg, New Delhi 110 001	As per I.S specification No. 15 -505-1968
27.	Hind Rubber Industries P. Ltd., Tardeo Road, Bombay 400 034	-
28.	Hindustan Tyres Pvt. Ltd., Opp: Agripada Police Stn., Nr. A. Nair Road, Bombay 400 011	Powder
29.	Inarco Ltd., 'Advent' 12-A, Fereshore Rd., Bombay 400 021	Cream to brown coloured powder Size: 120 mesh Oil absorption-25% Cu-less than 0.001% Mn-0.01% L.O.I-12.5%

1 2	3
30. Incheck Tyres Ltd., Leslie House, 19, Jawaharlal Nehru Road, Calcutta 700 015	Size: 200 mesh Moisture-2% mmax Water solubility 0.5% max
31. International Rubbr & General Industries Pvt. Ltd. 33, Dhirubhai Parikh Marg 1st Cross Lane, Bombay 400 002	Rubber grade
32. International Rubber ills, Baghpat Road PB No. 56 Meerut 250 002 Uttar Pradesh	-
33. Jai Hind Rubber Products (Pvt) Ltd., 391-F, Grant Road, Bombay 400 007	-
34. J.K Industries Ltd., 7, Council House Street Calcutta 700 001	Size: 200 mesh Sp-gr-2.5 to 2.6 pH-4.5 to 5.5 n-0.0025% max
35. Kale Rubber Works Pvt. Ltd., Behranji Mansion, Sir. P.M. Road, Bombay 400 001	-
36. Kedar Rubber Ltd., 46-B, Shakespeare Sarani, Calcutta 700 017	Powder
37. Madras Rubber Factory Ltd., Dhun Building 1/5/1, Anna Road Madras 600 002	Powder Size: 323 mesh Sp-gr-2.58 to 2.62 pH-4.5 to 6.5 Al_2O_3-38 to 41% : SiO_2-43 to 46% Fe_2O_3- 1% max : Mn-0.002% max Moisture -1% max : L.O.I-15% max
38. Modak Rubber Products Ltd. 'Kondivata Road', Opp. Moral Bazar, Andheri-Kurla Rd., Bombay 400 059	Size: 300 mesh free from grits (As per I.S specification, IS-505)
39. Modi Rubber Ltd., Modinagar 201 204 Dist: Meerut Uttar Pradesh	White to cream powder Size: 325 mesh Moisture-1% ax L.O.I-at $75^{o}C$ - 15% ,ax pH-5.5 to 7.5 Sp-gr-2.5 to 2.6 : Fe_2O_3- 0.5% max

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40.	National Rubber Manufacturers Ltd., "Leslie House," 19, Jawaharlal Nehru Rd., Calcutta 700 013	Size: 325 mesh. Grit content - 0.5%
41.	Orbetal Rubber Pvt. Ltd., 80, Acharya J.C Bose Road, Calcutta 700 014	-
42.	Oriental Rubber Industries Pvt. Ltd. PB No. 1828 United Bank of India Building Sir P.M Road, Bobay 400 001	Size: 325 mesh Moisture-1.25% max Sp-gr-2.5 to 1.8 pH-4.5 to 6.0 Water soluble-0.1% max Insolubility in HCl-95% min Feas Fe_2O_3-1.0% max Cu-0.005% max Mn-0.01% max Al as Al_2O_3-30% min L.O.I-11 to 14%
43.	Patoo Industrial Suppliers, 177-178, Industrial Estate Songli Dist: Sangli Maharashtra	-
44.	Paul Rubber Works, 9, Industrial Area, Faridabad 121 001 Dist: Gurgaon, Haryana,	-
45.	Perfect Oil Seals and Industrial Rubber Products, Plot No. 84, Bhoaart Industrial Area Poona 411 026 Maharashtra	-
46.	Phoenix Rubber Works P-83/1 Benaras Road, PO Daanagar, Dist: Howrah, West Bengal	-
47.	Precision Rubber Co. (India) PB No. 7718 Jaya Cinema Building Borivli West, Bombay 400 092	Super white

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48.	Premier Rubber & Cable Industries Jethalal Mansion, 10, Bank Street Cross Lane Fort, Bombay 400 020	Size: 325 mesh SiO_2-41-46% Al_2O_3-36-41%
49.	Premier Tyres Ltd., Merchant Chammbers, 41, New Marine LInes Bombay 400 020	Sie: 325 mesh Sp-gr-2.6 Purity-99.7%
50.	R.B.S Rubber Mills Pvt. Ltd. 3, Bentinck Street Calcutta 700 001	-
51.	Rubber Udyog Vikas Pvt. Ltd., P-5, Canning Stret Calcutta 700 001	-
52.	Ruby Rubber Works Ltd., PO Rubynagar Changanchery, Dist: Kottayam, Kerala	-
53.	Saoo Rubbers Pvt. ltd. 28/78, Punjabi Baug, New Delhi-110 026	-
54.	Satish Industries, Laxmi Vishnu Sadan, Maharshi Karve Rd., PB - 209, Naupada Thane-400 607 Maharashtra	White Kaolin
55.	S.G.R. Industries Pvt. Ltd., 10, The Mall, Dum Dum Calcutta 700 028	Rubber grade
56.	Ghree Products Ltd., H.A. Ltd., Compound, Bombay-Poona Road, Pimpri, Poona 411 018 Maharashtra	Powder
57.	Simplex Rubber Products Pvt. Ltd., Swastik Premises, Amraiwadi, Ahmedabad 380 008	Powder free from carbonate

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58.	South India Rubber Works, PB No. 132 Alleppey 688 001 Kerala	-
59.	Swastik Rubber-products ltd., Swastik House, Khadki, Poona 411 003 Maharashtra	Size: 325 mesh pH-4.5 to 5.5 Moisture-1% SiO_2 - 44-46% Al_2O_3 -37.5-39.5% Fe_2O_3 -1.5-2% TiO_2-1-2% L.O.I-13.6%
60.	T. Maneklal mfg. Co. Ltd., Viswani Mansion, Dinshaw Vachha Road, PB No. 11068 Marine Lines, Bobay 400 020	Size: 200 mmesh Sp-gr-2.7, pH-7 Acid solubility- below 2% Cu-less than 0.002% Fe-0.5% Mn-less than 0.013%
61.	Vidhyut Cable & Rubber Industries Plot No. 66 Govt. Industrial Estate, Kandivli(West) Bombay 400 067	-

Textile

1.	Ahmedabad Shri Ramkrishna Mills Co. Ltd., Gomtipur, Ahmedabad 380 021	-
2.	Ajudhia Textile Mills, (Unit of N.T.C) Vandhana Building, Tolstoy Marg, New Delhi 110 001	-
3.	Besanti Cotton Mills Ltd., Panihati, Dist: 24-Parganas, West Bengal.	-
4.	Bengal Fine Shipping & Weaving Mills 7, Bipin Behari Ganguly Street Calcutta	-
5.	Bengal Luxmi Cotton Mills ltd. 7, Jawaharlal Nehru Road, Calcutta 700 013	-

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6.	Bharat Survodaya Mills Company Ltd. Araiwadi Rd., PO Maninagar Ahmedabad 380 008	Size: 300 mesh
7.	Bharat Vijay Mills Ltd., Kalol, Dist: Mehsana Gujarat	Textile grade
8.	Binny Ltd., (Bunkingham & Carnatic Mills), 7, Armanian Street, PB-66 Madras 600 001	SiO_2-40% Min Al_2O_3-42-44% min L.O.I-15% max
9.	Binod Mills Company Ltd., Agar Road, Ujjain, Madhya Pradesh	-
10.	Bombay Dyeing & Manufacturing Company Ltd., Neville House, Graham Road, Bombay	White & free from grit
11.	Dowreah Cotton Mills Company Ltd., 21, Strand Road, Calcutta 700 001	-
12.	Cawnpore Textiles Ltd., 85/20, Cooperganj Kanpur, Uttar Pradesh	Size: 300 mesh
13.	Central India Spinning, Weaving & Manufacturing Co. Ltd., ("The Empress ills") Bombay House Bruce Street, Fort, Bombay 400 001	Lumps & powser Size: 300 mesh free from grit
14.	Century Spg. & Mfg. Co. Ltd., Century Bhavan, Dr. Annie Besant Rd., Worli Bombay 400 025	Lumps free from grits, iron oxides and carbonates
15.	Chhaganlal Textile Mills (Pvt) Ltd. Chowk, Bhopal Madhya Pradesh	Show-white, free from grit, iron and lime

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16.	Coorla Spg. & Wvg. Co. Ltd., "Nirmal" 241/242, Backbay Reclamation Bombay 400 001	Grade-I clay As per I.S specification
17.	Devangare Cotton Mills Ltd., Hanumanthappa Building Chitradeuga Road, PB 201 Dist: Chitradurga Karnataka	-
18.	Dewan Bahadur Ramgopal Mills Ltd. 1-2-630, Elchiguds, Hyderabad Andhra Pradesh	Textile grade
19.	Digvijay Textile Mills Lalbagh, Parel, Bombay 400 035	-
20.	Edward Mills, Beawar, 10th floor, Vandhana Bldg. 11, Tolstoy Marg New Delhi	-
21.	Elgin Mills Company Ltd., 11/6, Smt. Parbati Bangala Rd., Kanpur 208 001 Uttar Pradesh	-
22.	Elgin Mills Co Ltd Mill No.1 Civil Lines, Kanpur U.P.	-do-
23.	Elphinetons Spinning & Weaving ills Co. Ltd. Kamani Chambers 32, Nicol Rd, Ballard Estate Bombay 400 001.	Powder, textile grade
24.	Finlay Mills Ltd., Chartered Bank Building, Fort, Bombay 400 001	As per I.S specification
25.	Hindustan Spg. & Wvg. Mills Ltd. Sir Vithaldas Chambers, 16, Bombay Samachar Marg, Fort, Bombay 400 023	-

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26.	Jam Shri Ranjitsinghji Spg. & Wvg. Mills Co. Ltd., 11, Bank Street, Fort, Bombay 400 001	Textile grade
27.	J.K Manufacturers Ltd., Kamala Tower Kanpur Uttar Pradesh	-
28.	Kalyanmal Mills 15, Shilnath Camp, Indore-452 003 Madhya Pradesh	-
29.	Kesoram Industries & Cotton Mills Ltd., 9/1, R.N. ukherjee Rd., Calcutta 700 001	Textile grade
30.	Kohinoor Mills Co. Ltd., Killick House Home Street, Fort Bombay 400 001	-
31.	Lakshmi ratan Cotton Mills Co. Ltd., Behari Niwas, Kanpur Uttar Pradesh	Size: I.S Sieve No.8 L.O.I 16% max Moisture-3 Grit-0.2% Fe-0.35%
32.	Mafatlal Fine Spg. & Mfg. Co. Ltd., Mafatlal Center, Nariman Point, PB No. 10037, Bombay 400 021	Dull white powder Size: I.S. sieve No.8 L.O.I 15% max Moisture 3% max Fe-0.5%
33.	Mafatlal Fine Spg.& Mfg.Co.Ltd. Unit No.4, RS Nimbkar Marg Bombay 400 008	-do-
34.	Mahalakshmi Mills 10th floor, Vandana Bldg. 11, Tolstoy Marg, New Delhi 110 001	Textile grade
35.	Minerva Mills No. 1031, 80 Feet Road, Blocl IV, Balajinagar Bangalore 560 010	-
36.	Mohini Mills ltd Belgharia Calcutta 700 056	-

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37.	Muir Mills Co. Ltd., PB No.33 Kanpur 208 001 Uttar Pradesh	-
38.	Nandalal Bhandari Mills Ltd. 1-Snehalataganj Main Rd., PO No. 226 Indore-452 003 Madhya Pradesh	-
39.	Navsari Cotton & Silk Mills Ltd. Makani Manzil, 274, perin Nariman Street, Fort, Bombay 400 001	-
40	New City of Bombay Manufacturing Co. ltd. 63, Tukara Bhisaji Kadam path, (Chinchpokli Road), Bombay 400 033	-
41.	New Gujarat Cotton Mills Ltd., 16-A, Brabourne Rd., Calcutta 700 001	-
42.	New Kaiser-I-Hind Spg. & Wvg. Mills (New Hind Textile Mills) Indu House, 1st floor, 15, Narotta Morarji Marg Ballard Estate Bombay 400 001	-
43.	New Pratap Spg. Wvg. & Mfg. Company Vasanti Chambers, 47, New Marine Lines Bombay 400 020	-
44.	New Victoria Mills Co. Ltd., 14/1, Civil Lines Kanpur, Uttar Pradesh	Textile grade
45.	Orissa Textile Mills Ltd., PO Chowdwar, Dist: Cuttack Orissa	Lumps
46.	Oswanshali Mills (U.R.S) PB No.10, Mill Road Nanded, Maharashtra	-

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47. Pratap Spg. Wvg. & Mfg. Co. Ltd., Pratapnagar Amalner Dist: Jalgaon, Maharashtra	Gritless, snow-white
48. Pulgaon Cotton Mills, Ltd., 59, Bombay Samachar Marg, 2nd floor, Fort, Bombay 400 023	-
49. Rajkot Spinning & Weaving Mills 1791, Ashram Road Ahmedabad 380 009	-
50. Rampooria Cotton Mills 8/8, Lali Bazar Street Calcutta 700 001	-
51. R.B Bansilal Abirchand Spg. & WVg. Mills N.T.C House, 15, N. Morarji Marg Bombay 400 038	-
52. Shree Yamuna Mills Company Ltd., Shree Yamuna Mills Road Pratapnagar, Dist: Baroda, Gujarat	-
53. Sidhpur Mills Co. ltd., PB No. 6, Dist. Mehsana Gujarat	White, free from grit
54. Sri Bharthi Mills PB No. 10, Pondicherry 605 004	-
55. Surat Cotton Spg. & Wvg Mills Pvt. Ltd. Mafatlal House, Backbay Reclamation, PB No. 1088 Bombay 400 020	-
56. Swadeshi Cotton Mills Co. Ltd., Swadeshi House, Civil Lines, Kanpur 208 001 Uttar Pradesh	Cream white, lumps, and powder, Grit content-0.18%

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57.	Tata Mills Ltd. Bombay House Bruce Street, Fort, Bobay 400 001	-
58.	Technological Institute of Textiles PO Birla Colony Bhiwani 125 022 Haryana	Lumps
59.	Victoria Mills Ltd 104, Bharat House Apollo Street, Fort Bombay 400 001	-
60.	Vidartna Mills Berar Achalpur Maharashtra	-
61.	Western India Spinning & Manufacturing co. Ltd. Express Tower, 4th floor, Nariman Point, Bobay 400 001	Lumps

Vanaspati/Soap

1.	Indian Vegetable Products Ltd., Forbes Building, Charanjit Rai Marg. Bombay 400 001	-

Source: Directory of Mineral Consuming Industries - published by IBM, Nagpur.

CERAMIC PROJECT CONSULTANTS

1. Associated Enterprises
11, Bijason Road
(Ramchander Nagar)
Indore-452 005

2. Atul Consultants (P) Ltd
Post Bag No.8
Chandra Building
Kalkaji Tempale
New Delhi-110 019

3. (Dr) BVS Subba Rao
1-10-248/A Ashaknagar
Hyderabad-500 020
Andhra Pradesh

4. CP Consultants (P) Ltd
B-223, Chittaranjan Park
New Delhi-110 019

5. Consulting Engineering Services
(India) Pvt Ltd
57, Nehru Place
5th Floor
New Delhi-110 019

6. Ceramic Technological Institute
PB No.1245
Science Institute Post
Bangalore-560 012

7. Corporate All & Participative
Projects Pvt Ltd
GF-9, Meghoot
Nehru Place
New Delhi-110 019

8. Development Consultants Pvt Ltd
24B, Park Street
Calcutta-700 016

9. Eco Systems Group
2nd Floor, Giriraj
23 Nandanvan Society
Alkapuri
Baroda-390 005

10. Ecotech Consultants Pvt Ltd
Navrang Centre
Swastik Char Rasta, Navrangpura
Ahmmedabad-390 009

11. Emgee Management Consultants
(P) Ltd
Chatterjee International Centre
Chowringhee Road
Calcutta-700 071

12. HB Consultants & Engineers P.Ltd
202 Mmangal Chambers
Sant Tukaram Road
Bombmay-400 009

13. Haq Consultants
Baitul Fazal
2527, Agra Road
Jaiapur-302 003

14. Himalika Pvt Ltd
1876-A, Gurudwara Road
Kotla Mubarakpur
New Delhi-110 003

15. Industrial & Technical Consultancy
Organisation
50A, Graemmes Road
Madras-600 006

16. Industrial Management Consultancy
Organisation
G-23, Jangpura Extension PO
Box No.3351
New Delhi-110 014

17. Industrial Techno-Economic
Services
7, Community Centre
East of Kailash
New Delhi-110 065

18. Jasmul Filtrations
201, Gokul, Goraswadi
Malad (W)
Bombay-400 064

19. Jayces Consultancy Services
Opp. S.T. Stand
Devgarh Baria-389 380

20. K.K. Consultants
S-456 Greater Kailash
New Delhi

21. Mahajan Ceramic Services
Pvt. Ltd
B-8 Ram Balram Apartment
Post Box No.30
Kalol-382 721
Dist. Mehsana (N.G.)

22. M.M. Suri & Associates Pvt Ltd
Bhandari House
2nd Floor, Nehru Place
New Delhi-110 019

23. Mantec Consultants Pvt Ltd
805, Vishal Bhawan
95, Nehru Place
New Delhi-110 019

24. Overseas Industrial Consultants
85, Hamidia Road
Bhopal
Madhya Pradesh

25. Progro Management Consultants
Pvt Ltd
Aditya Centre
2nd Floor
Nr. Phulchhab Chow Sadar
Rajkot-360 001

CHINA CLAY PROSPECTING REPORTS

Sr. No.	Name of the Report	Field Season	District	Price (Rs.)
1.	A report on the investigation of china clay deposits in Sabarkantha and Mehsana districts.	1969-70	Sabarkantha Mehsana	2,500
2.	An interimm report on the china clay investigation in Sabarkantha district.	1970-71	Sabarkantha	2,500
3.	Report on the investigation for china clay around Kanara Karoli and Manpur village of Himatnagar taluka of Sabarkantha district.	1971-72	Sabarkantha	1,500
4.	Report on detailed survey scheme for clay in parts of Surat and Valsad districts.	1981-82	Surat Valsad	1,500
5.	Report on the drilling operation on china clay deposits in parts of Manpur and Kansara villages of Himatnagar taluka.	1976-77	Sabarkantha	2,500
6.	Report on survey scheme for clay in parts of Dediapada, Valia and Jhagadia taluka of Bharuch district.	1984-85	Bharuch	750
7.	Report on investigation for china clay around village Kadiyali taluka Rajula in Amreli dist.	1985-86	Amreli	1,500
8.	Report on Surat china clay scheme	1968-69	Surat	750
9.	Report on china clay deposits around Davad, Eklara, Arsodia villages of Sabarkantha district.	1969-73	Sabarkantha (compiled)	10,000
10.	Report on pre-detailed survey scheme for clay deposits in parts of Bharuch district.	1983-84	Bharuch	750

Sr. No.	Name of the Report	Field Season	District	Price (Rs.)
11.	Predetailed Mineral Survey of Rapar Taluka of Kachchh dist.	1985-86	Kachchh	750
12.	Predetailed Mineral Survey of Bhachaua taluka	1990-91	"	750
13.	Predetailed Mineral Survey of Rapar taluka of Kachchh dist.	1981-82	"	750
14.	Predetailed Mineral Survey of Rapar taluka of Kachchh dist.	1984-85	"	750
15.	Predetailed Mineral Survey of Rapar taluka of Kachchh dist.	1982-83	"	750
16.	Predetailed Mineral Survey of Rapar taluka of Kachchh dist.	1983-84	"	750
17.	Predetailed Mineral Survey of Rapar taluka of Kachchh dist.	1980-81	"	750
18.	Predetailed Mineral Survey for limestone & ceramic minerals of Bhachau taluka of Kachchh dist.	1978-70	"	750

Source: Directorate of Geology & Mining, Block No.1, New Mental Bldg. Meghaninagar, Ahmedabad-3780 016.

II
GEOLOGICAL SETTINGS

Geologically, Kaolin is derived by weathering of potash felspar. In Kaolinisation process felspar is attacked by carbonated water.

ORIGIN AND CHARACTERISTICS

Primary china clay is derived from kaolinization of granites.

$$2KAl + Si_3O_8 + H_2O\ 6CO_2 \text{ -------> } H_4Al_2 + SiO_2 + K_2CO_3$$

(Feldspar) (Carbonated water) (China clay + Silica) (Potassium carbonate)

Studies of x-ray diffraction, differential thermal analysis, infrared absorption, spectra study, electron microscopy etc. revealed that china clay was free from detectable impurities. Kaolinite was found as predoinent mineral with little halloysite which was observed as tabular structure having euhedral to sub-hedral crystal shape under electron microscope.

The quality of china clay is comparable with that of Cornwall, England.

GEOLOGY OF CHINA CLAYS

Kaolin occurs as both residual and transported deposits. Residual deposits are formed by the weathering of an aluminous rock source, commonly granite. Many are hydrothermal in origin. The highest quality and largest deposits worldwide represent the sedimentary type were kaolinite has been transported, deposited, and recrystallised to a varying degree. A classic example is the Georgia kaolin deposits.

Kaolin originates in at least three widely different geochemical environments: by weathering, by hydrothermal alteration and by crystallisation from colloids having a chemical composition similar to kaolinite. Certain physical properties such as bulk density and plasticity (slaking ability) are related to these different modes of origin. Keller (d) using a scanning electron microscope corelated the genetic environment of kaolins with the resulting texture. He concluded the open texture and expanded stacks of kaolinite crystals result from surface weathering, hydrothermal kaolinization within a relatively porous parent rock, or by sedimentation. This type of kaolin is free slaking and adaptable to industrial uses where high dispersion is required. A dense texture is developed by tightly inter-locking compact crystals of kaolinite (or halloysite) that result from crystallation from a colloid, as in flint, clay, or by hydrothermal kaolinization within confined space. Kaolin of this type resists slaking in water and does not possess natural plasticity. Its properties are indespensable in industrial uses where the grain size and high density of the crushed, crude clay must be maintained in a moist environment such as during the formation of refractory shapes.

Mineralogically, ball clays consist typically of kaolinite quartz, illite, smectite, chlorite, mica and carbonaceous matter. Kaolinite, which is mostly disordered, is the predominant mineral. The individual constituents vary considerably, even within a single deposit. Colour varies from light grey to black depending on the amount of lignite or carbonaceous matter in the clay. Because of these variations, extensive blending is conducted during and after mining to produce a uniform quality. The most important properties of ball clay for refractory use is its bonding strength and refractoriness. The excellent plasticity and bonding properties of ball clay are