

# **PROCESSING OF HIGH GRIT BALL CLAYS**

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**ABSTRACT:** In Sri Lanka high grit ball clay is not mined at all from the ball clay deposits as the process adopted in purification is Dry Processing. It involves dry grinding causing high wear and tear to the grinding mill. Hence the cut-off grade of ball clay for Mining and processing is determined by the grit content which is limited to a maximum of 2%. In this research the authors have experimented on high grit ball clay and have suggested a flow sheet for its processing. Though the capital outlay is high in the method suggested, authors' aim is to make use of this mineral deposit industrially with optimum utilization.

### **INTRODUCTION :**

In Sri Lanka, high quality ball clays are located in Dediyaawala in the Kalutara District (Fig.1 ). High Plasticity, low grit content and fine particle size associated with the ball clays are very desirable qualities in the manufacture of ceramics and porcelain. However, ball clay also finds many applications in Industry, very particularly Rubber and Plastics as a filler. It is the latter use that the authors are interested in. In this research various methods for the recovery of high quality ball clay from high grit ball clays have been tried ; of these the authors have isolated three separation routes depending upon the final quality of the product and the capital equipment to be utilized.

### **PRESENT METHOD OF EXTRACTION OF BALL CLAY.**

The method of extraction of Ball clay from Dediyaawala is by open cast mining. In this method the overburden soil cover approximately 4 to 5 ft. is removed either by hand or by using an excavator shovel attachment; thereafter the clay is mined. Present mining makes use of the power shovel attachment (Fig. 2). As the depth increases, the sand and grit content of clay increases and when the grit (mostly sand) content of the clay reaches 2% mining is stopped and thereafter no more extraction of clay takes place from there even if there is clay to the extent of 93% ( Fig. 3 ). This shows that the cut off grade for ball clay is controlled only by the grit content and not by the other factors. As a result vast quantities of Ball clay are going to be unutilized and wasted. The grit content of clay is the non clay fraction retained on 300 mesh B.S. sieve.

Ball clay is an industrial mineral, whose formation dates back to millions of years geologically. Therefore it is of paramount importance that this valuable resource is utilized to its maximum in Industry by adopting a suitable processing technique. With this view in mind a research program was initiated to process ball clay with high grit content on lab scale which can be scaled up to a processing plant.

## **VARIOUS PROCESSES ADOPTED:**

### **Process 1 – Flow Sheet.**

A method similar to the present method of processing using Drying, Crushing, Grinding and air separation.( Fig. 4) may be adopted. The coarse particle fraction by a single pass is separated out ( Single pass classification )using the air separator ( Fig.5 ) without closed circuit grinding.

#### Disadvantages :

Since there is a high grit content in the starting clay, it will be subjected to further grinding action to fine particles leading to a higher percentage of very fine non plastic fraction as shown in the size distribution graphs ( Fig.6) where the reduction of raw clay particle size from 74 microns to about 10 microns is apparent.

High wear and tear of the Hammer mill leading to the **replacement of Hammers** of the mill frequently. Above all, finely ground grit is a silicosis hazard to which the mill workers are exposed.

### **Process 2 - Flow Sheet**

The flow sheet in the Process 2 is the next strategy adopted to process the high grit ball clay where a grade similar to one obtained by processing mined clay with less than 2 % grit. was possible.

In this method a solar drying similar to what is being used as at present (Fig.7) was used followed by the reduction of moisture content of clay to less than 1% after passing through an indirectly heated spiral conveyor dryer. Unless the moisture is reduced below 1% the size reduction using a jaw crusher or a cone crusher is going to be a failure.

#### Advantages:

High grit ball clay can be processed and can be utilized in Industries

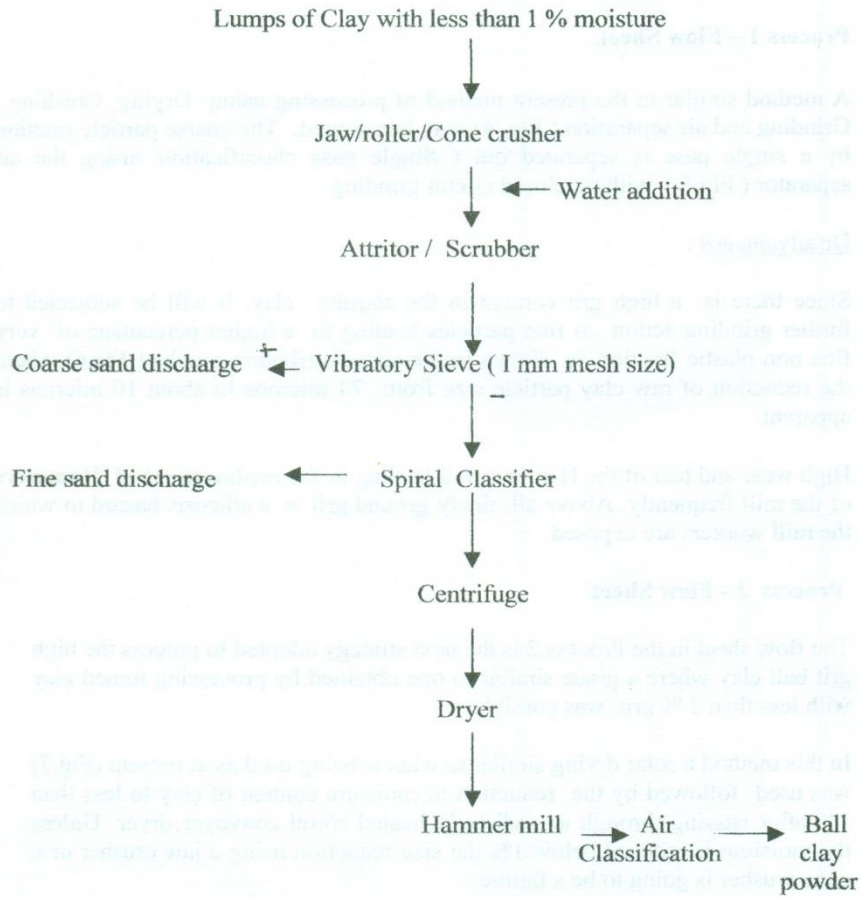
Less silicosis hazard

Powdered product meeting specifications as a filler mineral.

#### Disadvantages:

Utilisation of a Jaw , roller or cone crusher and other capital equipment.

## Process 2 – Flow Sheet

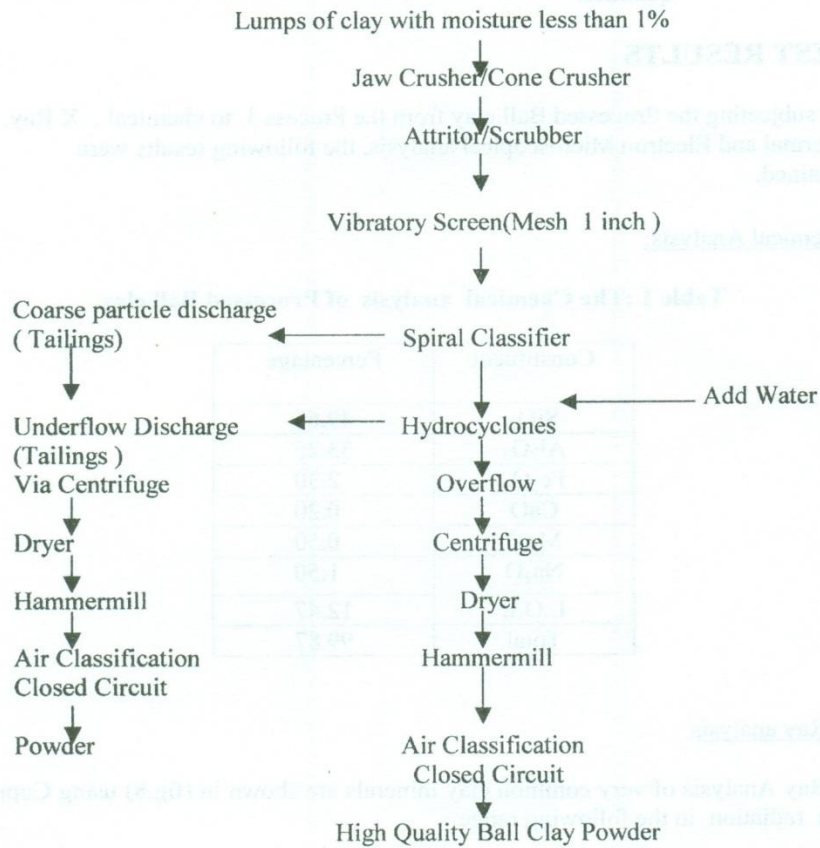


**Advantages:** High Quality ball clay powder ,optimum resource Utilisation.

**Disadvantages :** Utilisation of additional capital equipment ,such as; Jaw or cone crusher , attritor scrubber, vibratory sieve , spiral classifier , centrifuge & dryer .



### Process 3 – Flow Sheet



### Process 3- Flow sheet

In this flow sheet there are several capital equipments used to minimize the Ball clay losses and at the same time the clay produced will conform to the standards with respect to the particle size, plasticity and the grit content.

Advantages : Two powder grades can be recovered with the optimum utilization of the Reserves

Disadvantages : Utilisation of capital equipment such as jaw/or cone crusher, Attritor scrubber,vibratory screen, spiral classifier, two centrifuges, hydrocyclones, two dryers,two hammer mills and two air –classifiers because of products having different qualities.

## TEST RESULTS

By subjecting the Processed Ball clay from the Process 3 to chemical , X-Ray, Thermal and Electron Microscopical analysis, the following results were obtained.

### Chemical Analysis:

**Table 1 :The Chemical analysis of Processed Ball clay**

| Constituent                    | Percentage |
|--------------------------------|------------|
| SiO <sub>2</sub>               | 49.65      |
| Al <sub>2</sub> O <sub>3</sub> | 33.25      |
| Fe <sub>2</sub> O <sub>3</sub> | 2.30       |
| CaO                            | 0.20       |
| MgO                            | 0.50       |
| Na <sub>2</sub> O              | 1.50       |
| L.O.I.                         | 12.47      |
| Total                          | 99.87      |

### X-Ray analysis

X-Ray Analysis of very common clay minerals are shown in (fig.8) using Copper K a radiation in the following range

$$12^{\circ} < 2\theta < 25^{\circ}$$

Compared to the X-ray diffractometer curves A , 1 and 3 of the China Clays, the Ball Clay at Dediawala do not show sharp and well split peaks corresponding to the 111 , 110 and 020 which are very prominent in English China Clay.

The Sharpness of peaks is very apparent in Meetiyagoda China Clay but is not so in Boralesgamuwa China Clay.

The full X-Ray diffractometer traces with the  $2\theta$  angle in the range  $6^{\circ} < 2\theta < 41^{\circ}$  for the above three Clays are shown in (Fig. 9) , where the sharp peak splitting within the  $2\theta$  range  $19^{\circ}$  and  $22^{\circ}$  is very prominent. From these

observations the degree of crystallinity of Sri Lankan industrial Clays can be arranged in the following order.

**English China Clay > Meetiyagoda Clay > Boralesgamuwa Clay > Dediawala Ball Clay**

#### Differential Thermal Analysis

Differential Thermal Analysis of Dediawala Ball Clay is compared with the China clays from Boralesgamuwa and Meetiyagoda. (Fig. 10)

Dediawala Ball Clay - DTA trace 2 has the following peaks:

A broad endothermic peak between  $100^{\circ}\text{C}$  to  $250^{\circ}\text{C}$  due to the elimination of water.

An endothermic peak between  $300^{\circ}\text{C}$  to  $350^{\circ}\text{C}$  due to decomposition of hydrated iron oxide impurities.

An exothermic peak at  $450^{\circ}\text{C}$  to  $500^{\circ}\text{C}$  due to the oxidation of Carbonic matter.

An Endothermic peak at  $580^{\circ}\text{C}$  which is apparent in all the clays

An Exothermic peak at  $950^{\circ}\text{C}$ , which is rather broad and diminished in the case of Ball Clay but fairly sharp in the others.

#### Electron Microscopic Studies.

The Electron Microscopical Examination of Dediawala Ball clay reveals that some particles of Ball clay are irregular where as the rest look hexagonal with less clearly defined edges ( Fig. 11 ).

From the micrograph it is evident that overall clay particles falls into semi crystalline variety having an average particle size of about 0.2 microns. This feature might have some connection with the high plasticity of Ball Clay

#### **CONCLUSION:**

In this research, it has been shown that it is possible to process high grit Ball clays using the sequence of operations shown in Processes 1, 2 and 3. To obtain high quality Ball clay powder flow sheet corresponding to the process 3 is suitable even though there is going to high capital outlay. The research is preliminary at this stage as there are more detailed areas to be experimented using a spiral classifier and continuous centrifuge on pilot scale.

## ACKNOWLEDGEMENT:

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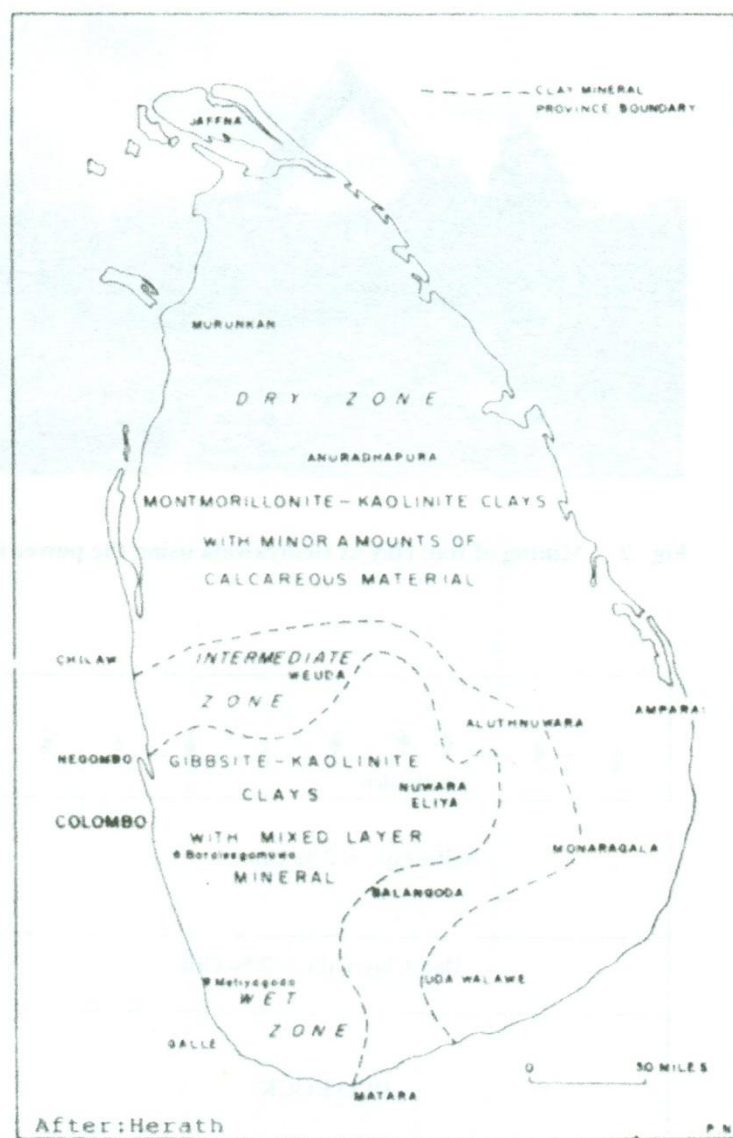
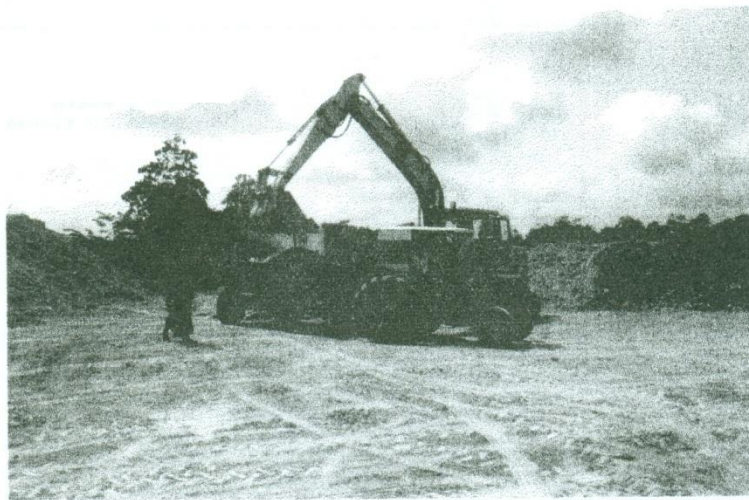
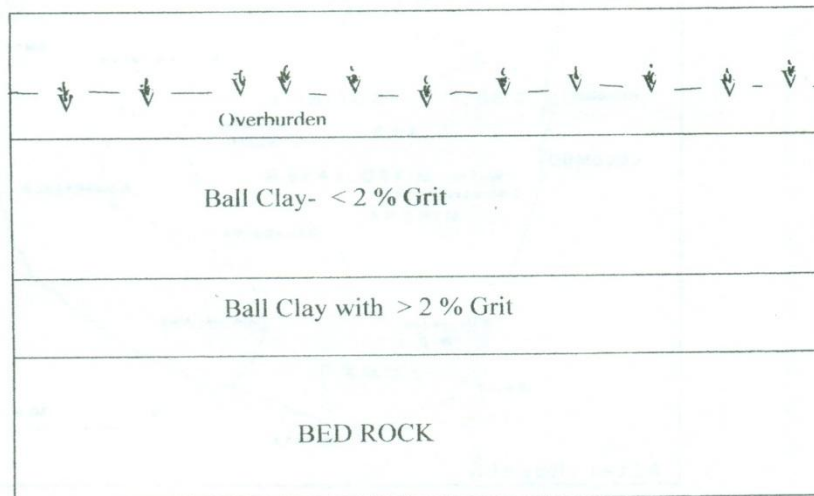


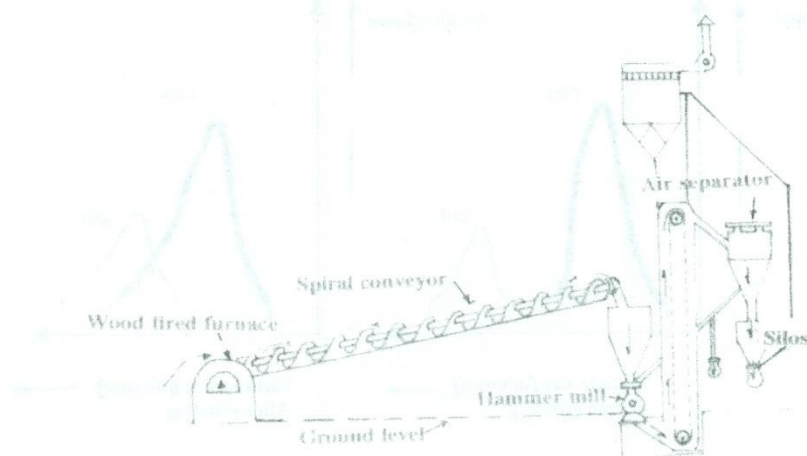
Fig. 1 Clay mineral provinces<sup>i</sup>



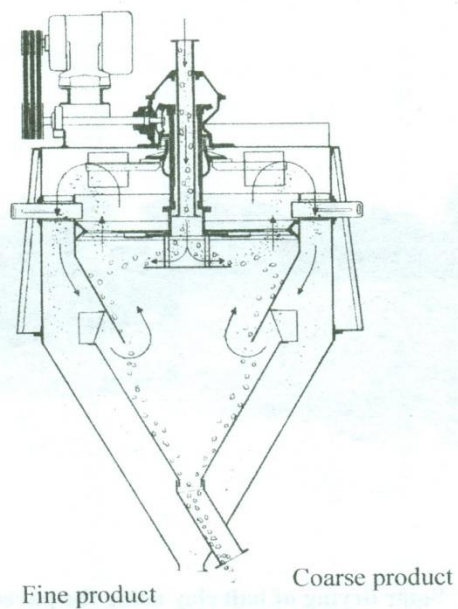
**Fig .2 Mining of Ball clay at Dediawala using the power shovel**



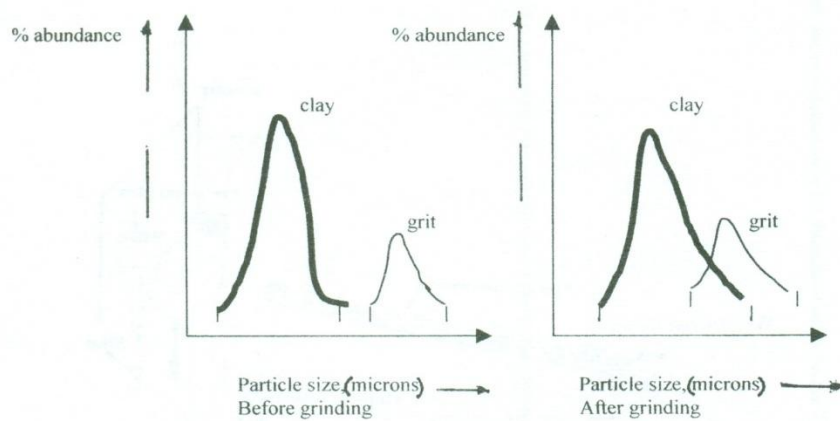
**Fig. 3 Profile of Ball Clay deposit- Sectional view**



**Fig. 4 Flow chart of Ball clay processing in the existing plant**



**Fig. 5 Air Separator**



Note : Movement of size distribution pattern of grit before and after grinding

**Fig 6. Particle size distribution patterns for Ball clay and the associated grit particles in the run of mine ball clay and the processed clay.**



**Fig 7. Solar drying of ball clay using the paved area**



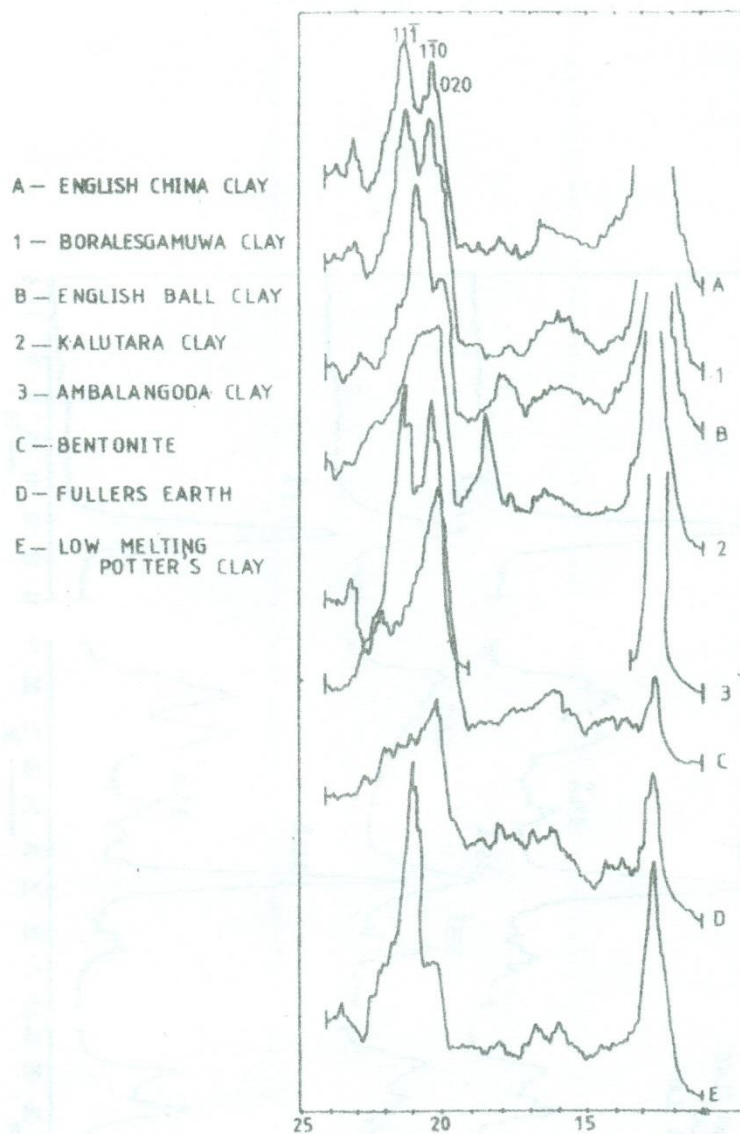


Fig. 8 X-ray diffractometer traces for common clay minerals using Cu  $K\alpha$  radiation

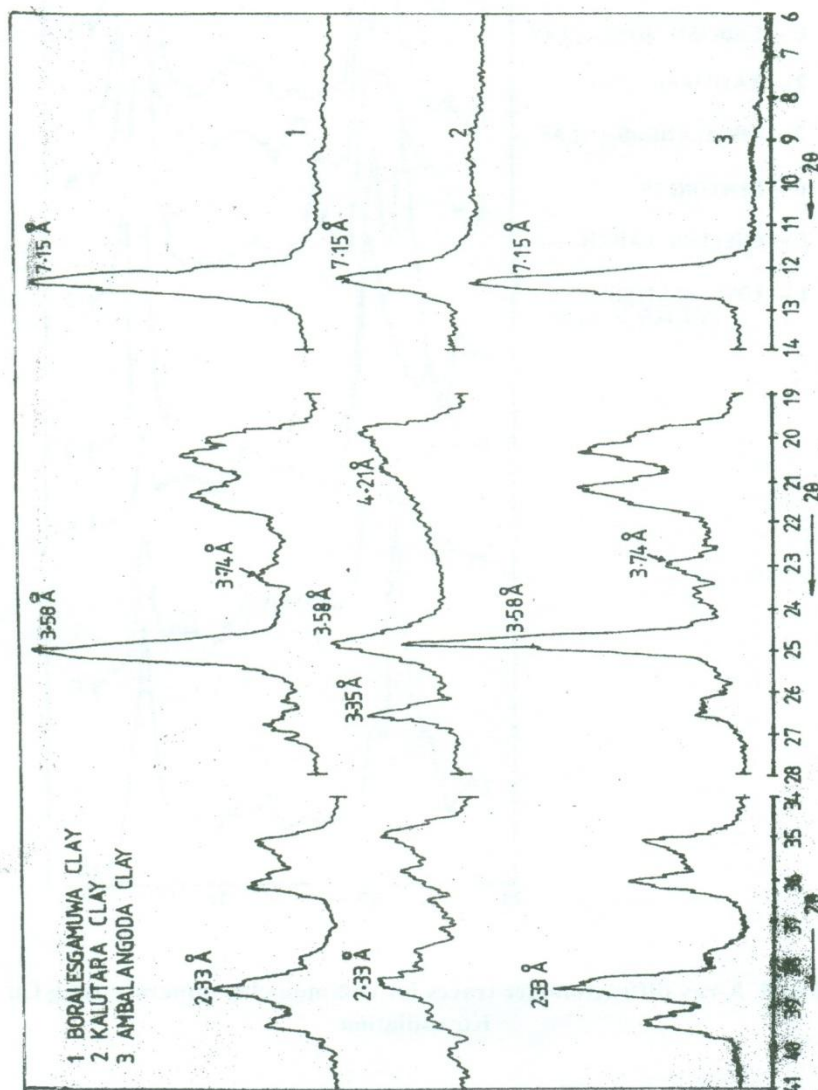


Fig. 9 Full X-ray diffractometer traces for three clay minerals indicated as above

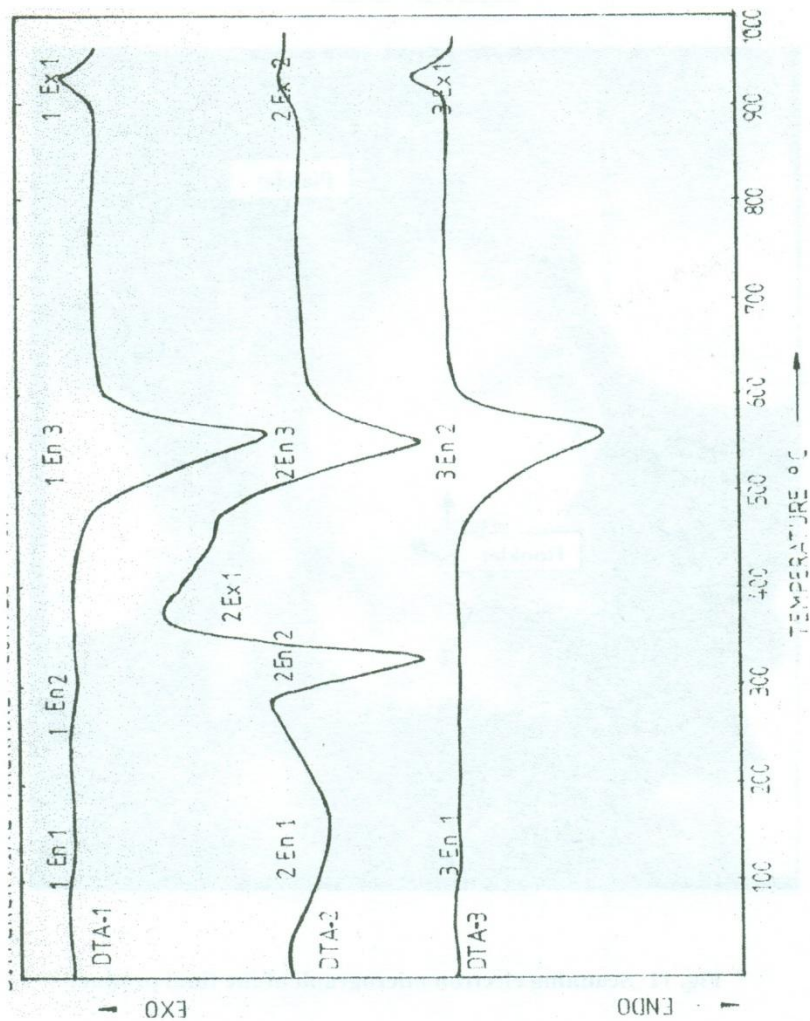
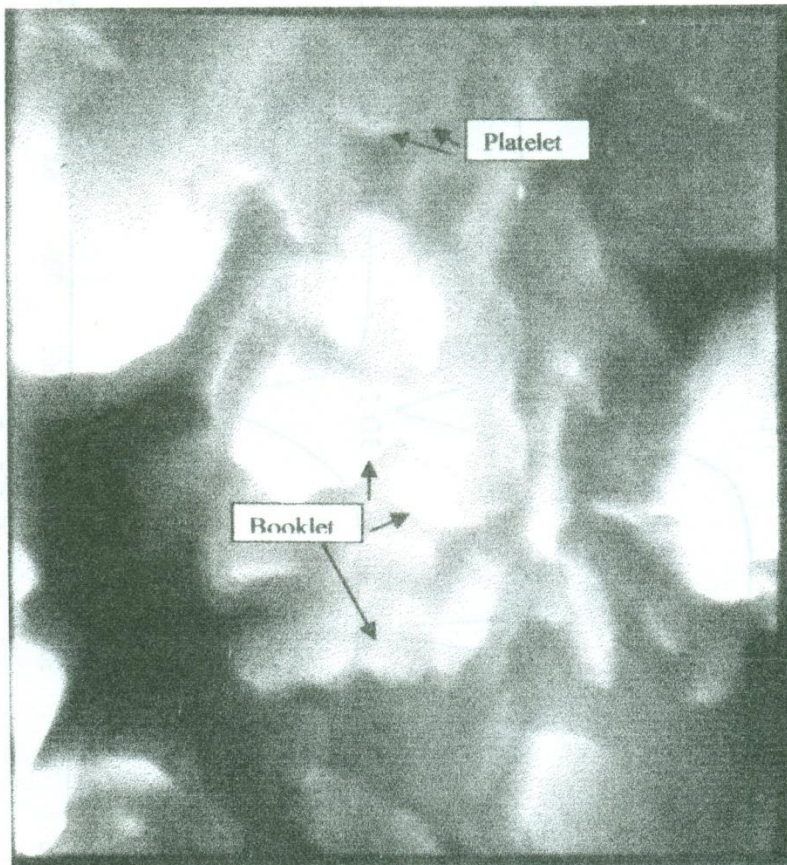


Fig. 10 Differential thermal curves for the processed clays

Bar - 0.5 microns



**Fig. 11 Scanning electron micrograph of the final product**