OCCURRENCE OF SILLIMANITE IN TRAVANCORE AND ITS IMPORTANCE AND USES.

The Indian scientist as well as the industrialist has not given the attention it merits towards the development of India's mineral wealth. India possesses vast mineral resources lying buried waiting for economic and Industrial development. These are so varied and extensive that even the briefest description will grow into a book. The purpose of the present paper is to draw attention towards a mineral which, though occurring in India, especially in Travancore state, has not been utilised for any useful purpose. Nevertheless it is an important mineral and an asset to the State and if properly worked will prove a good source of income.

Sillimanite is a rock-forming mineral belonging to the aluminium sillicate group and is represented by the formula $Al_2 Sio_5$ and crystallises in the ortho-rhombic system. It usually occurs in a massive form.

Occurrence of sillimanite in Travancore.

We are extremely fortunate to possess sillimanite in Travancore, considering its great importance in the manufacture of " sillimanitic porcelain " and special refractories which possess characteristic and decided advantages over ordinary porcelain also called quartzitic porcelain.

The sillimanite found in Travancore is in grain form and is found abundantly in the beach-sand associated with ilmenite, garnet, monazite and zircon sands. From these components of the beach-sand sillimanite can be separated by means of suitable mechanical means. This will prove a very good source of supply if proper and efficient methods are employed for its separation. Another independent as well as cheap means by which sillimanite is obtainable is as a bye-product during the China Clay washing process.

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Sillimanite and its importance.

Electrical insulators of ordinary porcelain serve their purpose admirably when used for ordinary purposes of electrical insulation for currents of usual voltage. But when used for insulation of electric currents of high voltage they fail to serve the purpose. The reason is that due to the very high resistance, which they offer to the current, they become heated and the material has to bear a very great strain. This cannot be sustained indefinitely hence the insulator either breaks or loses its efficiency permanently by developing fine cracks.

Again the demands upon the chemical and pharmaceutical porcelain-ware are rather severe. Generally they are required to be heated to varying high temperatures in a short space of time, to save time and expenditure (these factors being of utmost importance from the manufacturer's point of view). At these temperatures they are often removed from the furnace or the stoves, the sudden change in temperature to which they are thus subjected is very often the cause of their breaking and experimenter or the manufacturer has not only to bear a certain loss but is exposed to great personal danger as well.

Further such chemical ware must stand the chemical action of strong acids, alkalies, and other compounds of a corrosive nature.

Hence the nature of these processes requires that these articles must possess good thermal endurance, low coefficient of expansion and high load bearing strength. They must be highly refractory and must be immune to a great extent to the corrosive action of chemicals.

Superiority of Sillimanitic Porcelain over ordinary Porcelain.

Sillimanitic porcelain and refractories fulfil these requirements admirably and may be exclusively used for the purpose of manufacturing chemical ware highly resistant to the corrosive action of chemicals and electrical insulators offering perfect insulation even at very high voltages.

The laboratory-ware made of sillimanitic porcelain such as crucibles, evaporating dishes, beakers, funnels, combustion boats, combustion tubes, delivery tubes, spatulas, spoons, and a host of other requisites, which the chemist, the pharmaceutist and the metallurgist daily require are much more durable, have a greater power of enduring thermal shocks and are better conductors of heat than those made of ordinary porcelain.

Further, the ordinary and high tension insulators, made of sillimanitic porcelain offer a much superior insulation and are able to bear and sustain admirably a very high electrical pressure, necessitated by the modern developments in Hydro-electric projects and powerful internal-combustion engines used in high powered cars and aeroplanes.

In the industrial field, the introduction of ware made of sillimanitic porcelain and sillimanitic refractories will not only help in reducing the cost of manufacture of different chemical and pharmaceutical preparations but make the process of their manufacture safer as well. The use of imported ordinary porcelain ware is naturally costly on account of the greater manufacturing costs in the foreign countries as well as the losses on breakages, during transit due to its fragile nature. This is one of the reasons which has hampered the progress of heavy and fine chemicals manufactured in India.

The sillimanite porcelain is not so fragile and considerably more durable than the "quartzitic" porcelain and consequently its use will be much more economical.

Why Sillimanitic Porcelain is more durable.

The observations made above regarding the superiority of "sillimanitic porcelain" over the ordinary porcelain for the manufacture of ware for chemical and pharmaceutical purposes and high class insulators are fully borne out by the research carried out by the author at the Ceramic Laboratory of the Benares Hindu University, the results of which are embodied in a detailed technical paper by the author.

It is necessary here to give in short the theory which explains to a great extent the superiority of sillimanitic porcelain over the ordinary porcelain for the particular purposes mentioned.

The inherent defects of insulators and Laboratory ware of "Quartzitic porcelain" as their inability to resist sudden changes of electric pressure and temperature resulting in cracking and breakage are explained on the basis of the following theory.

The grains of quartz when heated in the presence of felspar at temperatures 1400°C to 1500°C are dissolved by the felspar, the rapidity of the solution depending upon the mobility of the molten sillicate in contact with the particles of quartz.

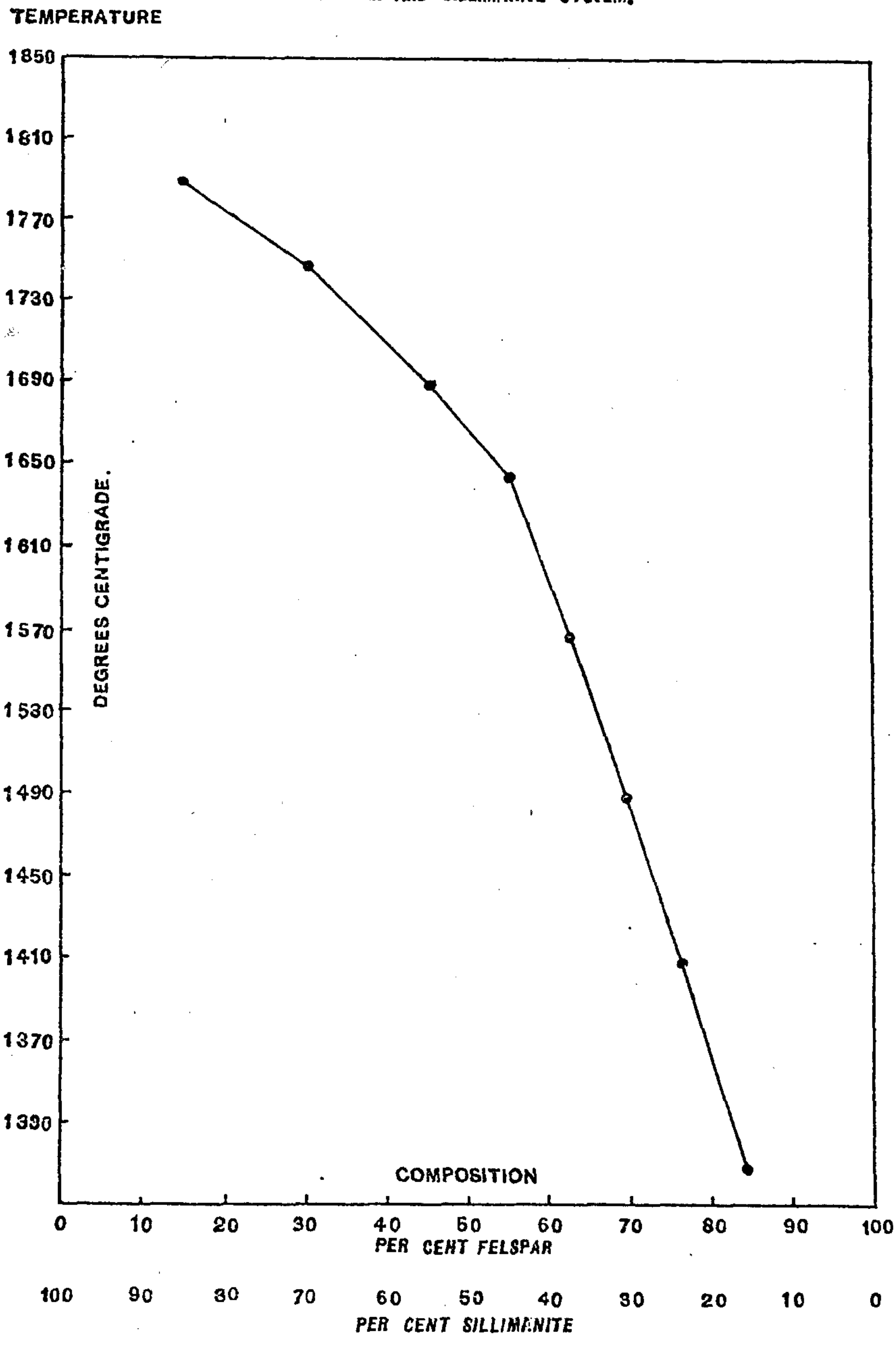
Simultaneously with the solution of quartz grains two allotropic modifications of quartz, trydamite and christobelite come into existence and crystallisation sets in, the reason being that the molten felspar has greater power of dissolving the quartz particles than its allotropic modifications, which therefore separate and crystallise.

Now when "quartzitic porcelain" is subjected to sudden and repeated temperature changes the amorphous matrix caused by the fusion of sillicate does not allow the quartz crystals to expand or contract uniformly in all directions, hence the crystal tries to accommodate itself by developing a crack along the cleavage plane. This is one of the fundamental causes of breakage of the laboratory porcelain wares.

Also when an insulator body made of "Quartzitic" porcelain used for electrical purposes is subjected to continuous action of an electric current, a change begins to occur in the volume of the crystal. When

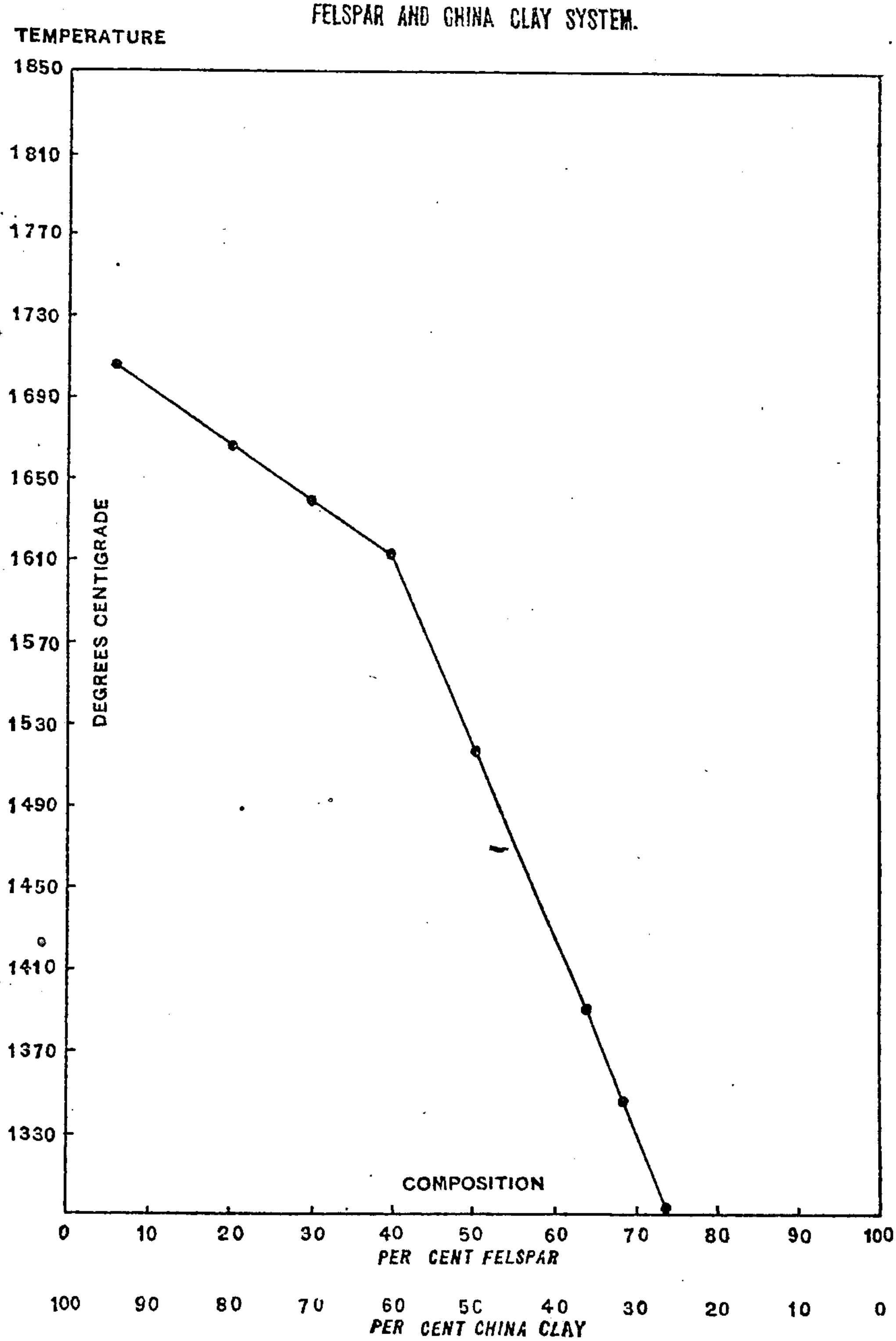
FUSION CURVE OF

FELSPAR AND SILLIMANITE SYSTEM.



Litho, Survey Office, Trivandrum. 1938 A. D/ 1113 M. E.

FUSION CURVE OF FELSPAR AND CHINA CLAY SYSTEM.



Litho, Survey Office, Trivandrum. 1938 A. D/ 1113 M. E.

these volume-changes are hampered by the surrounding matrix, great local stresses are developed. Consequently when an insulator is placed in a field of alternating electrostatic force, a vibratory movement occurs, which causes the quartz crystal to crack along its cleavage plane. The gap then produced is the main source of leakage of current, and fall in the dielectric strength.

Sillimanite crystals due to their highly refractory nature and low constant coefficient of expansion resist the attack of felspar much better than the crystals of quartz in the early stages of firing. Later as the temperature rises, they are more or less completely dissolved. But unlike quartz crystals, no allotropic modification comes into existence followed by partial crystallisation for sillimanite becomes monotropic after firing. Hence sillimanite crystals when mixed with essential ingredients of porcelain produce an ideal body which is chemically and physically in equilibrium and has a homogeneous non-porus structure which bears thermal and electrical shocks admirably.

The fusion curves of China clay + Felspar and sillimanite + Felspar systems shown are self explanatory, showing that the latter system has got a much higher melting point than the china clay—Felspar system. This is uudoubtedly due to the higher refractoriness and the peculiar structure of the sillimanite particles. This constitutes an important point of superiority of the sillimanite porcelain over the ordinary porcelain as far as the electric insulator and hard-duty chemical ware are concerned.

The molten felspar according to Dr. Mellor is supposed to be absorbed by the porous cell-like particles of China clay which is the cause of translucency in the "quartzitic porcelain"

I have found that the "sillimanitic porcelain" is not so translucent. This in my opinion is due to the fact that sillimanite crystals are not porous and cell-like as of china Clay. This accounts for the loss of translucency.

The uniformity and perception in the shape of the porcelain ware, depend upon the behaviour of the clay particles towards the electrolytes. These are used to increase the consistency and running power of the slip using the least amount of water to facilitate the casting of the wares.

It is found that the finely ground sillimanite particles behave exactly like clay particles so far as their behaviour towards the electrolyte is concerned. Hence uniform and thinner wares could be produced without any difficulty in the manufacture.

The glaze which has been developed by the author is equally superior, and is quite immune to the chemical action of acids, alkalies and gases even at high temperatures.

No extra costs are entailed for the manufacture of sillimanitic porcelain.

Further investigations are in progress and the results will be published in due course of time.

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