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Petrographic Analysis of Ceramic Artifacts From Ban Di Kiln, Pattani Province, Thailand

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ABSTRACT

This research paper aims to investigate the components of archaeological ceramic artifacts collected from Ban Di kiln, Pattani province, Thailand. The procedure involves the petrographic examination of fragments of ceramic artifacts, focusing on raw materials, sources of materials, and production techniques. Ban Di ceramics date back to 16th and 17th centuries, the period in which ancient Patani had enjoyed its prosperity in domestic and foreign trade. This study shows that alluvial soils from coastal plains, with high content of sand, are predominant materials in the manufacture. The production process involves jiggering and hot pressing at the firing temperatures between 400-550° C.

Keywords: Petrography, Ceramic, Ban Di Kiln

INTRODUCTION

Maritime trade in Southeast Asian flourished in the 16th and 17th centuries. The spice trade in Moluccas drew attention from foreign countries, especially European countries. Southeast Asian ports and entrepots had been established for commercial transaction, one of which was the port of ancient Patani, on the east coast of the Malay Peninsula. Because of its suitable location, the port of Patani attracted both Western and Eastern merchants. It not only offered a refuge for cargo ships during Monsoon seasons, but was also a distribution center and abundant in natural resources. In 16th and 17th centuries, ancient Patani had a thriving foreign trade with both Eastern and Western countries, namely China, Japan, India, Arab, Portugal and the Netherlands, as well as an internal trade with Ayutthaya and Nakhon Si Thammarat (Sukkasem, 2007).

A preliminary archaeological survey of this major port of ancient Patani shows that it is now located in Kalae-buesa, Muang District, Pattani province. The expedition took place along a tributary of Pattani River, which flows past Tiyeraya village, Mor Moh port, Dee village, Parae village, until reaching Pattani Bay (Buakaew, 1997). A number of mounds and sherds uncovered at Ban Di Community, Brahome Subdistrict, Muang, Pattani, reveal a likelihood that this area used to be an ancient kiln. This finding led to an archaeological excavation in 1994, which indicates that this clay oven, approximately 270 centimeters in diameter, is an updraft slab kiln. An electromagnetic survey of the kiln and the found products reveals that this ancient kiln could operate at temperatures ranging from 800°C-1500°C (Srisuchat, 1999).

Unglazed and thin glazed earthenware objects are found from this kiln. Typological classification shows the most common shape of wide-mouth pots formed by throwing and decorated by a combination of incised lines and stamped patterns: geometric shape, quatrefoil, bullet wood, gerbera, cordmarks, zigzag, and etc. (Sombatyanuchit A, 2004). Ban Di pottery was also found at 2 important archaeological sites in Japan, Yao's house site and Tagashima's house site, both dating back to the 17th century. The excavation led to the discovery of Hizan ware, Jing de-chen and Sa-wato ware, apart from Ban

Di ceramic objects. The dating of ceramic fragments indicates that they belonged to the 16th-17th centuries (Srisuchat 1999), the periods of prosperous trade of ancient Patani. This evidence shows that the pottery making at Ban Di was probably a small-scale industry that emphasizes utility purposes, for household use as well as for use in cargo ships, especially for international trades with Japan (Srisuchat 1996).

Nevertheless, most of the archaeological studies regarding Ban Di ceramics are concerned with their underlying attributes and mainly use relative dating. A study of ancient technology and folk wisdom involved in the production process necessitates a scientific analysis that entails a survey and research of raw materials, their sources and quantity, and other properties. Investigation in terms of production techniques and procedures is also important (Prompruk1980).Petrographic characterization is one method for mineralogical analysis. An application of this method in ceramic study helps provide such evidence as mineral compositions, particle sizes, or changes from firing, e.g. cracking. This data provides sources and quantity of materials used for the manufacture, including production techniques, such as the firing.

Presently, archaeological studies require and involve scientific knowledge and application. This study provides knowledge and understanding of production techniques of ancient ceramics of local people in the South. More importantly, it is found that the making of these ceramic objects was primarily intended for local needs in the South and for foreign exports. In other words, this evidence indicates both the potential of ceramic products made from this ancient kiln and prospering trade of a former ancient city, Patani. Results from petrographic analysis also offer evidence that can be used for further archaeological studies.

ARCHAEOLOGICAL PROCESS

An archaeological site of Ban Di is located at Moo 3, Barahome subdistrict, Muang district, Pattani province, Thailand. Geographically, it lies between 6° 52′ 9.4-10.9″N and 101° 19′ 4-7.8″ E. This site was first explored in 1993, leading to an archaeological excavation of an 2x2m test pit in 1994.

Figure 1: Map of Thailand and areas in Pattani

The test pit excavation revealed 6 layers of soil, and traces of human habitation were evident on the C horizon, which is approximately 1.5 meters from the top layer. On this layer, a number of potsherds were unearthed, and a long trail of burned areas and ashes were found. The topsoil was composed of shell fragments, 10 cm thick. It is estimated that pottery production and the building of pottery kiln were started by inhabitants on the fourth layer. This ancient kiln was a updraft slab kilns built approximately 50 centimeters above the ground. It had a firebox at the base, 30 cm thick double walls, and a round hearth, about 270 cm in diameter. The top part of the kiln had collapsed. An electromagnetic survey around the kiln and of the ceramic remnants indicates that the kiln had a firing capacity at temperatures from 800 to 1150 °C.

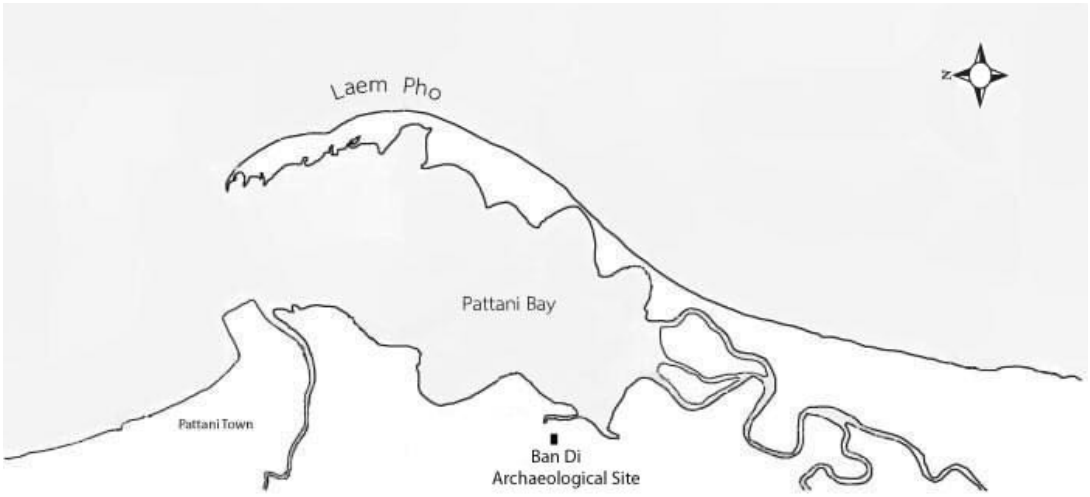


Figure 2. Ban Di Archaeological Site, Pattani Province

SAMPLES AND ANALYTICAL PROCESS

Petrographic analysis is an application of geological techniques that are used to describe and classify rocks and minerals in order to determine their origins, formations, structures and history. Petrographic analysis is related to pedological method that involves microscopic examination of soil origin, minerals, and textures. According to Prudence (1987) and Colin and Paul (1994), mineralogical analysis of earthenware objects helps classifying their fabric by identifying quantity and quality of mineral properties, such as quartz, mica, felspar, and crystalline materials. Petrographic analysis also entails in-depth structural analysis of archaeological artifacts, which yields evidence regarding their compositions, e.g. rocks, minerals, glass, soil and organic matters or metal. This method is essential for investigating microscopic components, as well as examining every single step of production techniques-- materials, soil textures and compositions, forming process, decorating techniques and firing temperatures. The results of this study not only provides knowledge of ancient technology but also contributes to archaeological studies of this technology.

An analysis of the 10 ceramic samples involves the following 4 steps:

1) examining and recording physical features of the samples, e.g. size, shape, type and color of soil, and external decoration;
2) making slides of ceramic samples;
3) examining mineralogical and microstructural ceramic composition under polarised microscope; and
4) interpretation and discussion of the findings

Outer surface | Inner surface | Inner core

Figure 3. Samples no. 2

RESULTS

Raw Materials

An overall analysis of raw material and soil texture indicates that these ceramic artifacts are earthenware made of alluvial soil from coastal plains and the content of igneous rock. This finding is in accord with the results from analyzing sample slides that show the high content of single quartz grains, or 'sand grains', which are

ubiquitous along the coastal plains, and 10-20% of lithic fragments. Particle size analysis of mineral samples shows ranges from powdered sand to medium sand. The results also show a composition of mica, biotite, and organic material in the samples under study. More importantly, this evidence suggests the likelihood that the soil used for the making of these ceramics is from the top layer of soil, or at least 50 cm from the ground. An investigation of geomorphological evidence and parent material of soil at Ban Di yields similar findings. A former river basin, this plain is found to comprise brackish water deposits made up of sandy loam on the top layer and organic matter at the layer over 30 cm deep. This data is congruent with evidence regarding source of raw materials. Apart from the use of alluvial soil from coastal plain, the component of fine texture soil found in Ban Di ceramic artifacts suggest that the production process of these ceramics may involve soil preparation, e.g., soil screening and soil sedimentation.

An analysis of chemical composition shows that Ban Di soil can be classified as siliceous clay which contains a high proportion of free silica. Obviously, soil with low minerals yields lower plasticity, unfired strength and drying shrinkage than soil with high minerals. It is also found that Ban Di soil contains as much as 14-25 percent of alumina, a proportion that can reduce soil plasticity if it is in the form of free alumina. However, petrographic analysis reveals no organic component, such as rice husk, in the clay body. It is then assumed that increasing soil plasticity is one of the steps prior to the manufacture.

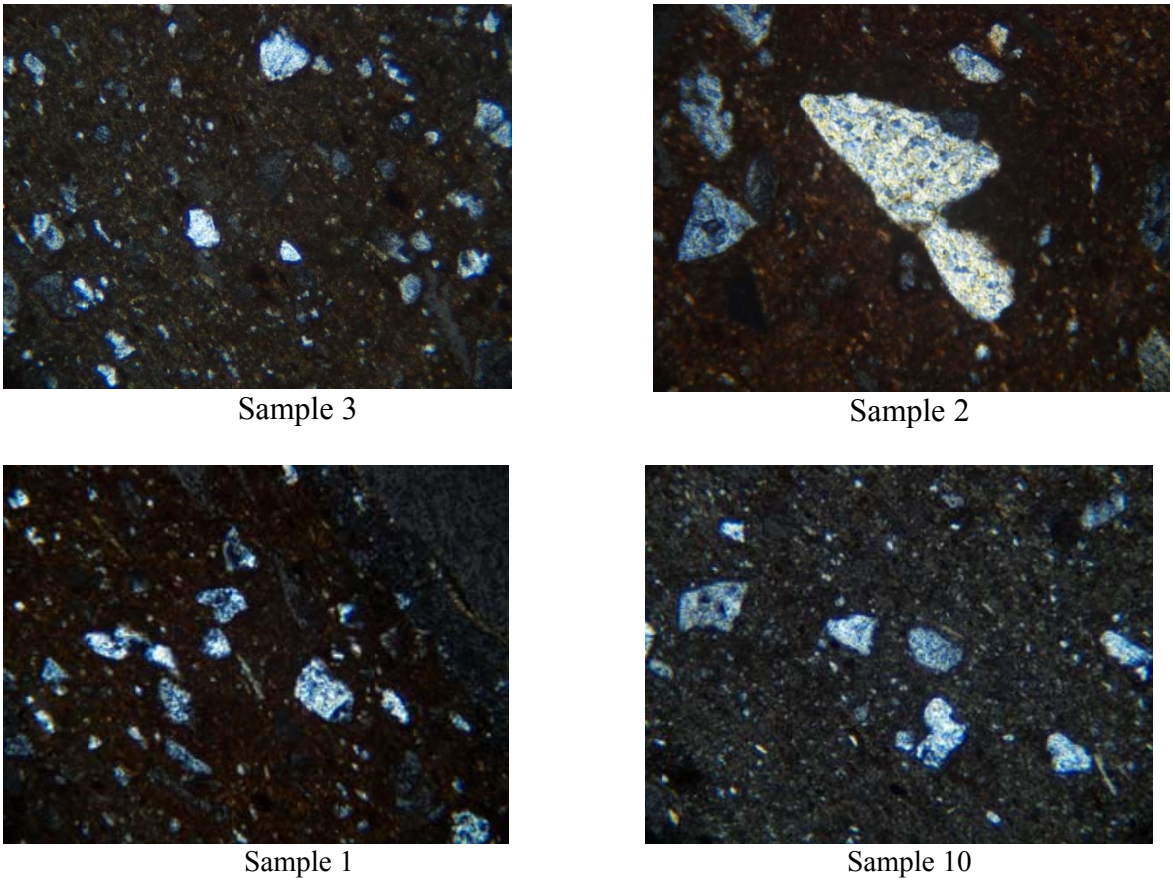


Figure 4. Single-quartz grains in soil texture

Component

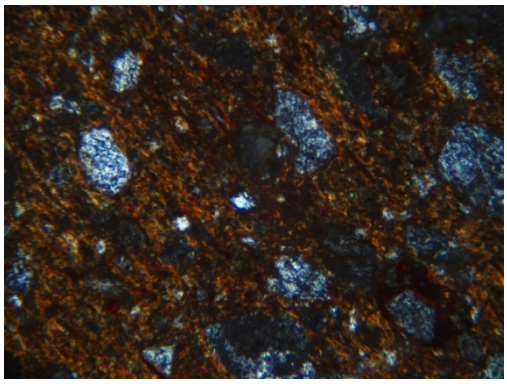
An analysis of soil composition in 10 ceramic samples reveals a mixture of pure clay-like soil commonly found at alluvial plains. This finding implies ancient craftsmen's knowledge of the quality of this type of soil for the manufacture of pottery. High plasticity and durability of the products exhibit the majority of quartz, or sand, in the soil texture. Fragments of Ban Di ceramic artifacts are found to contain 5-25% of quartz, a suitable amount for pottery production which helps reducing cracking. High sand content contributes to cohesiveness during the forming and shaping and distribution of heat to reach a state of maturity during the firing process.

Forming Techniques

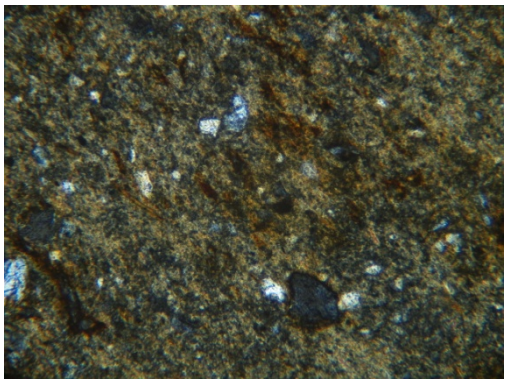
An analysis of the samples slides shows that the rim, neck and body of the Ban Di vessels have an average thickness of 0.6–0.9 cm. This similarity suggests the production of pottery of the same pattern and size. A study of forming techniques reveals the following results:

Throwing on the potter's wheel—Clay bodies are found to be oriented in the same direction, as shown in samples 1, 3, 4, 6 and 9, (fingerprints are found on the internal surface of sample 1). This suggests a step of soil preparation in the production process. Similar thickness of the rim, neck and body part of the wares also exhibits this type of forming.

Unidentified groups—While soil orientation pattern is not found in samples 2, 5, 7, 8 and 10, incoherent arrangement is apparent in some samples, probably resulting from the abundance of amorphous substances of organic matter. The mineral composition of this sample group consists of essential minerals and feldspar. There is no significant difference in its thickness and size. Though this earthenware is made from the same kiln at Ban Di, it remains uncertain whether this sample group is formed or shaped by a potter's wheel, like the first group. Yet, it is estimated that production techniques of this sample group are not much different



Sample 4



Sample 6

Sample 1

Fingerprints on interior surface of Sample 1

Figure 5. Soil orientation patterns from wheel-throwing

Surface Decorating Techniques

Analysis of decorative patterns of Ban Di ceramics reveals the followingfindings:

1) Five samples have smooth surfaces, both interior and exterior: the rim of Sample 5, the necks of

Samples 4 and 7, and the body parts of Samples 6 and 8;

2) Patterns by impressing are found only on the external surface of the body parts of Samples 1, 2, 3,9

and 10, while the internal has a smooth surface. The body parts of these ceramic samples are also similar in thickness, that is, 0.6-0.7 cm, suggesting a step of surface preparation prior to decorating process. Five different

types of carved blocks are used to create patterns on the samples under study, yet the patterns on some samples, e.g. Samples 1 and 3, are not distinct. One explanation is that clay body may be stamped while it is too dry, or it may be pressed too lightly, or the block itself wears down after a long use. It is also likely that these ceramic vessels may have been used for so long that the decorative patterns wear away. Nevertheless, clearer patterns can be seen Samples 2, 9 and 10. This may result from the use of wooden carved blocks, as well as a proper stage of surface treatment and soil preparation in the production process. Decorative patterns of Ban Di ceramics are

found to be beautiful and suitable for their use. Decoration for other purposes is also evident. For instance, different patterns on the body parts of 5 samples show uniqueness of ceramic products from this kiln. Despite dissimilar patterns, decorating techniques are alike. Resemblance in soil texture and other compositions also reflects commonality of source of production.

Figure 6. Patterns on ceramic samples

Firing Temperature

Mineralogical analysis of the unearthed pottery from Ban Di kiln shows evidence of important clay minerals, i.e. quartz, slag, and rubble, which indicates firing temperature between 400-550°C. It was found that these firing temperatures did not destroy or change crystalline structure of the soil, or burn down organic matter in it. Evidence from almost all samples shows the firing process with steady heat, as can be from Sample 9 that has the same color all over. This evidence then suggests that this ceramic ware is produced in the kiln. Another supporting evidence is the efficient control of firing temperature. Although there is no clear or sufficient evidence of what this ancient kiln is like, there is a likelihood that the kiln where this earthenware is made is an efficient clay kiln capable of producing high quality wares. This finding is consistent with the ceramic porosity analysis of the samples that indicates firing heat as a cause of the cleavage in the samples. Only 2-5% of porosity is found in each sample. This small value indicates a proper preparation and effective firing operation in the production processes.

CONCLUSION

During 1400-1680, Southeast Asia was in the "age of commerce." Different states conducted trades with foreign merchants. Pattani Bay, with nearly 20 km coastline, was a suitable anchorage for seafarers during Monsoon climate. This place soon became a port and an entrepot of foreign trade. Foreign merchants were attracted by Pattani's products, namely pepper, tin, ivory, hides, gold, and rice. The place also served as a depot of goods from various places, such as spices and sandalwood from Java and Molucca, rice and cotton from Champa, India, Sumatra and Cambodia. Other important products, which had not been mentioned in the list of foreign trades, were ceramics. According to archaeological

evidence, these ceramics were made for sale in locality, vicinity, as well as foreign countries. Typological classification of these ceramics reveal a common shape of wide-mouth pots formed by a potter's wheel and decorated by incising and stamping. Ceramic patterns are varied: geometric shape, quatrefoil, bullet wood, gerbera, cordmarks, zigzag, etc. Petrographic analysis of mineral composition in the ceramic artifacts indicates alluvial soil from coastal plains, which is made up of sand, as source material. These ceramic wares are thrown on a potter's wheel, decorated by stamping and fired at temperature between 400 — 550° C.

This research study can be regarded as a starting point for an archaeological study through petrographic methods. It is hoped that the results of this study will serve as database for further archaeological studies of other ceramic artifacts in other areas in the South.

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