

Ceramic Kiln Lineages in Mainland Southeast Asia

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Influence and Inspiration

Regional, technological, and stylistic factors indicate that historic high-temperature ceramic kilns in Mainland Southeast Asia derive from two separate sources of Chinese influence and that the kilns are distinctly defined by particular inherent characteristics. The kilns of one source are predominantly found along the eastern coast and adjacent interior, while the kilns of the second source are associated with inland riverine and upland areas. Herein, the two areas are termed the “Coastal Zone,” corresponding geographically to the present-day nations of Vietnam and Cambodia (with the exception of some interior areas), and the “Inland Zone,” largely contained within modern Burma, Thailand, and Laos (figs. 1, 2).

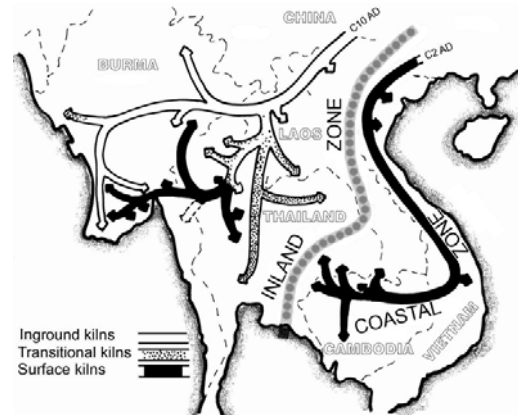


Figure 1. Zones of influence.

The establishment of kiln sites along the eastern coast suggests a route of influence from a parent site located in southeastern China, whereas the kilns of the Inland Zone are mostly located in the interior and concentrated in the north so that an inland route of influence is inferred. The two events of influence were separated by centuries of time and concern not only different production technology, but also ceramic wares dissimilar in form and design.

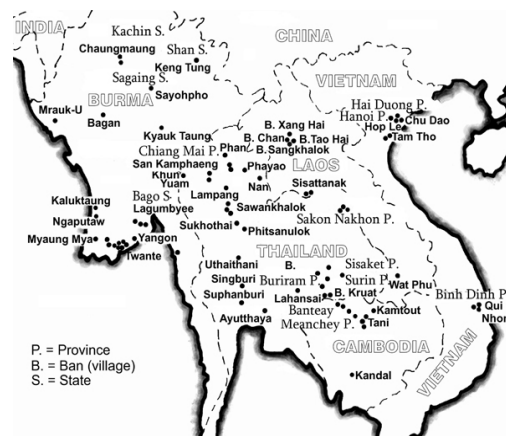


Figure 2. Locations of ceramic production sites in Mainland Southeast Asia.

While recognizing a long history spanning thousands of years during which earthenware pottery employing the bonfire process was made in the region, the present subject focuses upon the introduction of the crossdraft kiln into Southeast Asia and the production of high-temperature earthenware, stoneware, and glazed ware. The physical distinction between the two ceramic states is

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due to clay type, firing temperature, and the degree of vitrification, hence porosity, hardness, and durability.

The development in China of the crossdraft kiln marks the point when controlled temperatures required for the making of stoneware became achievable, and it was this invention that was passed on to Southeast Asia so fortuitously many centuries later. One reason such important industrial knowledge became widespread may be that dissemination initially occurred quite early in the evolution of the crossdraft kiln, when it was widely used for making cheap domestic utensils. As more sophisticated versions of the kiln operating in certain ceramic-making centers began to create wares of greater beauty and commercial value, more care was taken to avoid loss of that industrial knowledge and expertise. The version of the crossdraft kiln that passed to Southeast Asia was a relatively primitive (and probably provincial) form, either simply dug entirely into the earth or built of clay on the surface, small in size, created at little cost, and probably operated seasonally by farmer potters. Such kilns have a wide distribution in Southeast Asia and in many cases constitute the only kiln type used. Variation in kiln form and detail suggests local innovation and modification of the basic concept or—less likely but possible in some cases—subsequent transfer from Chinese sources. Over time, kilns—especially those committed to the quality demands of export trade—became more technically advanced and the design more standardized. In China, development led to kiln constructions of clay slab or brick in various forms on the ground surface, best represented by the *mantou* (“steamed bun”) downdraft kiln and the *long* (“dragon”) or hill kiln (crossdraft in principle but elongated) built up the slope of inclined ground (Medley 1976; Yang and Zhang 1986; Kerr and Wood 2004). However, these are not kiln types found in historic Southeast Asia.

In Southeast Asia specialization led over time to modifications of kilns of the original introduced type to meet particular needs, including the production of large water jars, food-serving wares unmarked by setting scars, and certain colored glazes that required particular firing conditions. Such modifications often appear to parallel changes in the organization of the particular ceramic industry, which—in the most economically successful cases—grew from family-based operations into corporate enterprises based on centralized management and specialized workers, transportation, and trade roles. Although the ceramic technology given to Southeast Asia developed to the point that some centers were successfully able to imitate the products of China, none were able to duplicate the technical and commercial acumen that underlay Chinese ceramic production. Whatever the level of organization, the viability of production was determined by the marketplace. With few exceptions, Southeast Asia ceramic production centers in those areas accessible to open trade gradually declined and died in the face of cheaper ceramic goods of higher quality from China.

As a working hypothesis, this paper aims to demonstrate a broad cycle from source influence through development and dissemination of knowledge and skill to commercial conclusion. It proposes means and routes along which founding influence probably moved and attempts to separate local innovation from introduced concepts, particularly in respect to the means of production. Above all it proposes a dichotomy of influence that indelibly marks the recipient areas with distinct technological characteristics that have the potential to identify the original source.

The definition of the accomplishments of Southeast Asian potters is a recent and unfinished work. Much is yet to be discovered, especially in the Inland Zone, where research access remains limited. However, the level of recognized achievement is significant, to the point that some industrial infrastructure and wares are unique and in one case the founding technology enhanced by centuries of innovation may have returned to China.

The Evolution and Function of Kilns

The following summary of kiln evolution and function (drawn from Hein 2001) should be prefaced by referencing the distinction between earthenware (often called pottery) and higher-temperature ceramics (most commonly termed stoneware). The general difference is clear. Earthenware is a product of clay artifacts fired to a temperature between 700 and 1100 degrees Centigrade and therefore is relatively porous and structurally weak. Due to greater fused cohesion of clay particles and crystalline structure, stoneware is virtually impervious to water and more durable. “Stoneware” is used in this essay as a general term to denote all higher-temperature ceramics made in historical Southeast Asia.

In the region, earthenware was (and commonly still is) burned in an open bonfire of straw, rice husk, animal dung, bamboo, wood, or similar fuel, although in some cases updraft kilns were employed for higher-quality wares. In comparison, the production of stoneware requires refractory clay able to withstand temperatures of up to 1280 degrees Centigrade without melting to the point that wares begin to deform, and the means to provide those temperatures. Due to critical chemical changes (including loss of chemical water and crystallization) that occur in clay at higher temperatures, stoneware needs to be fired in controlled conditions, including a regulated temperature gradient. Metal furnaces that can rapidly reach high temperatures have been known for millennia, but such conditions are not suitable for the successful firing of stoneware. A stoneware kiln needs to operate such that all of the contained wares reach maturation temperature at about the same time, something difficult or impractical in a metal furnace or updraft kiln. Because of the probable role of the updraft kiln in the invention of the crossdraft kiln—and because only those two kiln types are found in Mainland Southeast Asia—an understanding of updraft kilns is relevant to this discussion.

Development and use of updraft kilns suitable for firing earthenware is very old and widespread. Remains of a well-developed (unambiguous) form of the updraft kiln dating back more than 6,000 years have been found at Banpo near Xian in Shaanxi province, northern China (Kerr and Wood 2004:290). Updraft kilns are depicted in ancient Egyptian wall murals and in the pictorial decoration of classical Greek pottery, while archaeological remains of kilns also bear witness to their ancient use. In essence, an updraft kiln is a (usually) cylindrical structure that has a firing chamber (a space to contain the objects to be fired) positioned more or less above a firebox (where the fuel burns), separated by a perforated grate on which the wares rest. This upright arrangement means that the fire travels upward through the wares. Updraft kilns in the Middle East and Europe and some early Chinese updraft kilns were most commonly enclosed with a domed roof and had an access door in the side, whereas in Southeast Asia the (much later) kilns were open-topped

to facilitate loading and were temporarily closed (clamped) with pieces of broken jar or similar materials during firing.

Due to better containment of heat than a bonfire and more efficient draft, updraft kilns are capable of producing higher temperatures. In a manner similar to the bonfire process, the wares can be compactly stacked in contact within the kiln. The physical nature of heat to rise and find the most open path means that updraft kilns tend to have a significant range of temperature within the firing chamber. This is not necessarily a major problem in the manufacture of earthenware, as it may be fired to various levels of vitrification (even in one object) yet still be a quite satisfactory product.

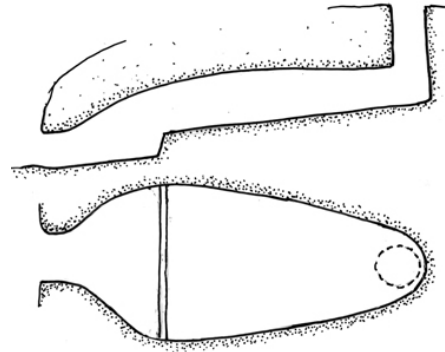


Fig. 3. Inground kiln with a straight firewall and a small chimney dug upwards through the ceiling of the firing chamber.

In comparison the crossdraft kiln has the same main components as the updraft kiln, with the omission of the grate and addition of a separate chimney or vent system, but these elements are arranged horizontally to create an elongated shape, with the fire source at one end and a chimney or vent at the opposite end (fig. 3). It appears that early forms of the kiln had a continuous floor from the firebox to the chimney and that later the firebox became offset below the level of the firing chamber (fig. 4). This development may have been a consequence of the intermittent firing cycle: After each firing, ash had to be scraped out, and this process kept the firebox floor at its original level or eroded slightly downwards. At the same time, material such as sand and small pieces of ceramic debris tended to become fused to the floor of the firing chamber near the fire, gradually resulting in increased height at that point. These processes produced an offset between the firebox floor and the firing chamber floor, which caused the fire to be located at a lower level than the wares to be fired. Early potters apparently realized several advantages to this change. One was that a greater amount of heat entered the firing chamber at a lower point (i.e., closer to the firing chamber floor), thereby reducing the temperature gradient between the floor and the ceiling. Another was increased draft. As to whether that may or may not have been an advantage, further explanation that anticipates later description is required. It should be noted that change to the firebox is one of the most significant dynamics in crossdraft kiln evolution.

Crossdraft kilns dug entirely into the ground as a horizontal hole—the type known as the inground kiln—required sufficient thickness of the sediment above the firing chamber to provide stability and inhibit collapse, which meant that the chimney extended from the end of the firing chamber a meter or more up to the ground surface (figs. 3–5). The draft pressure in a kiln is determined by the vertical distance between the firehole opening and the chimney exit, and the obligatory chimney height of inground kilns was a major factor in the generation of draft. Alteration to the draft height by deepening the firebox, such that the firehole was lowered, would cause a change in the firing regimen, a result that the potter would

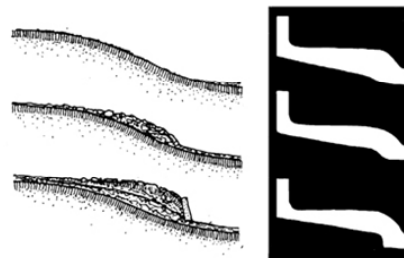


Figure 4. Stages of firewall development.

need to understand and control.¹ A further positive effect is that the offset provided more space for combustion to take place before the draft passed through the wares, thereby giving higher and more even temperatures. The firewall was curved in the earlier kilns as it became established along the perimeter of the fire, but in later kilns the firewall was made straight across the kiln to allow the fire to occupy as near as possible the full width of the kiln, thereby improving combustion and promoting more even distribution of heat. As crossdraft kilns developed, the firewall became higher and more upright and the firebox proportionately bigger in volume to provide more space for fuel and combustion and therefore the greater generation of heat.

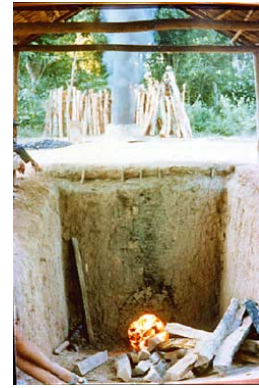


Fig. 5. Inground kiln at Ban Chan near Luang Prabang, Laos. Note timber being dried around chimney.

Eventually, kilns began to come out of the ground—not as an attempt to reinvent the kiln, but probably to solve certain problems such as dampness (“damp foot”) and the inconvenience of having to carry wares and fuel down a slope or into a deep firing pit. There may have been another compelling inspiration. The part of the kiln most subject to damage from melting and exfoliation (spalling) was the firing chamber ceiling. The need to patch holes frequently or—when the damage became too bad—to dig an entirely new (inground) kiln in another place was the bane of the potter. At times a weakened ceiling led to the total collapse of the sediment above the firing chamber. Faced with the task of digging a new kiln, inventive potters may have been encouraged to consider ways to repair the damage. Some may have attempted to renew the upper part with manipulated clay *in situ* (although no case has been identified), but they apparently realized that it would be easier to dig the kiln partly into the ground, then construct a dome.

In turn, the problem of constructing the dome had to be addressed. In what seems to have been the conceptually simplest answer, raw clay was manipulated over a temporary framework or other support to create a single slab of clay about fifteen centimeters thick. (The dome was not, as sometimes mistakenly thought, made with prepared slabs of clay.)

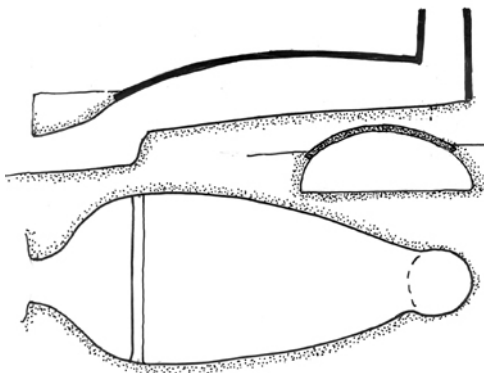


Fig. 6. General form of a transitional kiln, this the example with a brick dome.

Impressions on the inner-wall face of some excavated kilns show that sometimes the framework was made of latticed bamboo that was later burned out. Another method is suggested by the absence of such impressions on the walls of other kilns of the type. After the lower part of the kiln had been dug out, sand or sediment could have been heaped in and shaped to the desired contour of the dome, and clay then manipulated over the fill. After drying, the fill could (easily) be dug out. Conceptually, this proposed method is the simplest extension of past practice. In the case of a transitional kiln dome made of brick, either method for creating

¹ In Burma the floors of some crossdraft kiln fireboxes slope towards the firewall, perhaps as a way of deepening firebox while leaving the firehole in the same relative position.

the framework might have been employed. With the innovation of the renewable dome, the transitional kiln was born (fig. 6). How that occurred in China is not known. The kiln introduced in the Coastal Zone was already a surface or transitional type, but in the Inland Zone, especially at Sawankhalok in Thailand, this evolutionary process can be observed. (It will be discussed below.)

There is one significant difference between the potential of the dome of inground and constructed kiln types. The clay sediment into which inground kilns were dug provided sufficient stability to allow (if preferred) a nearly flat ceiling, but a constructed dome had to be arched. The arch could cause some difficulty in setting (arranging) certain wares into the kiln. Firing efficiency demands that a kiln be evenly filled. The setting problem for surface kilns became more significant as kilns increased in size and imposed greater height on the firing chamber.

Taking the half-step toward a fully surface kiln temporarily avoided an unprecedented problem. The dome of the inground kiln was part of the sediment into which the kiln was dug and did not require engineered support; either by anticipation or good fortune, the transitional kiln allowed the outward thrust of the constructed dome to be met by the natural sediment on which it rested. The walls of a crossdraft kiln entirely built on the ground surface, whether constructed of clay or of brick, were structurally weak, primarily due to the walls' expanding and softening during firing and the reverse during cooling (when most damage occurred), and to the outward thrust of the dome. Therefore, additional support was required. This was achieved by encasing the sides of the kiln within a revetment filled with clay, sand, or ceramic debris—the method still used today for working kilns of the type (see fig. 38). When the revetment was poorly maintained or eroded after abandonment of the site, the dome collapsed, a condition often found in archaeology. Some brick construction had the advantage of not requiring a framework for support during construction, as the bricks could be set at an incline to allow the structure to be self-supporting (although buttresses may have been progressively applied as the walls were built).

Kilns required a shelter primarily to protect against rain. For inground kilns, only the area immediately outside the firehole where the potters worked (or the firing pit) needed protection, but the exposed bodies of transitional kilns and the buttresses of surface kilns required more substantial shelter. In fact, the infrastructure of an independent kiln would have included sheltered storage areas for clay, water, and fuel; a potting workshop; racking for unfired (green) wares; and living accommodations. Taking some current traditional practice as a guide, all of these were often in the one large shelter that also housed the kiln.

Once freed from the design constraints imposed by the inground context, the shape of the surface kiln could be modified to advantage (fig. 7). The most obvious change is that the firing chamber floor gradually became inclined at a greater angle (from 7–15°C) and the chimney came to be

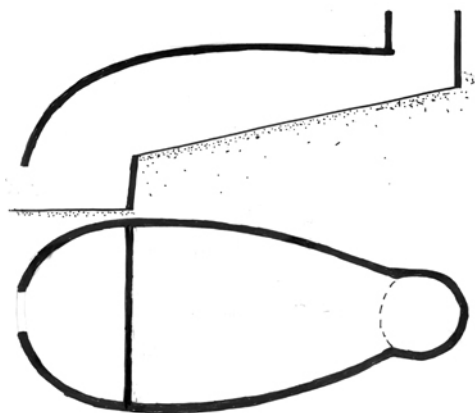


Fig. 7. Brick-built surface kiln at Sawankhalok, Thailand.

correspondingly lower and larger in diameter, which allowed more even draft. The kilns also became larger (longer, wider, and higher), probably in an attempt to provide a more economical firing cycle and to better meet output demand.

The internal shape of a kiln and the method of construction are probably the most dominant generic features and those that underwent least frequent modification. In the process of change, the retention of existing ideas is evident, as illustrated by the following example.

In the case of inground kilns, structural stability required that a wall of earth of up to fifty centimeters thick be left between the inside and the outside of the firebox near the firehole, where the potter had to work—the only exposed part of the kiln. That obliged the kiln to have a tunnel-like extension of the firebox. The form was also necessary for transitional kilns. That the first surface kilns made entirely of brick had a similar but functionally useless protuberance illustrates the mindset of the kiln builders who simply continued to replicate what they knew (fig. 8).



Fig. 8. Protruding firebox of a brick surface kiln, No. 55, at Sawankhalok. Note chimney of nearby inground kiln.

Another example of concept continuity is related to the use of loading doors in the firing chamber wall. These are common in the *long* kilns of China and Central Vietnam but do not appear at all in the Inland Zone, where their absence may be explained by two factors. Inground kilns required two essential apertures—one as a firehole, the other as exit for the draft—and the impracticality of a loading door meant that wares passed through the firebox. When the inground kiln evolved into a surface kiln, loading doors were still not employed, perhaps simply because the old practice of loading through the firehole was not reconsidered. Another probable reason why old ways were continued is that, in the case of kilns with inclined floors, it is physically easier to set the wares beginning at the top of the slope near the chimney and working downwards (and backwards) to the firebox. As the firing chamber as the chimney end is narrower, using that method also means that fewer pots have to be passed along its length.

It might be argued that changes from inground through a transitional stage to surface kilns could have resulted either from external influence or from local innovation. At the time, however, no similar surface kiln from which the concept could have come appears to have existed anywhere in Southeast Asia or China. The concept of the surface kiln made of brick in Southeast Asia is inherent in the transitional and inground kilns that preceded it. It is unlikely that potters setting out independently to invent a kiln made of brick should invent one that demanded the contorted use of brick to replicate the ovoid dome of the earthen firing chamber (fig. 9). The notion of external influence or independent invention is



Fig. 9. An exacting brick pattern was required to reproduce the traditional ovoid shape of the dome.

unsupportable, at least at Sawankhalok, where the potters had the experience and knowledge of the inground phase and carried redundant features into new kilns.



Fig. 10. A family pottery at Mudon (see also fig. 27).

Understanding of the operational significance of the various crossdraft kiln types may be enhanced by a brief description of how such a kiln functions. For each intermittent cycle the firing chamber of the kiln is loaded with wares, and depending on the ware type and technology, various methods are used to set the wares either on or in each other, on supports, or in saggars throughout the chamber. Whatever the system, the rationale is to use the available space most efficiently, control draft flow most effectively, and make best use of the kiln's temperature

characteristics. Although the aim is to create as even a temperature as possible throughout the firing chamber, differences occur. The temperature is lower at the floor than near the ceiling and decreases toward the chimney. The offset firebox compensates for the first condition; to reduce the effect of the second, the cross-sectional area of the firing chamber is decreased toward the chimney either by a narrowed ground plan or by decreased height, or both. Two thermal conditions result. As heat is absorbed by the wares and kiln body and the atmosphere cools and contracts in volume, the narrowing space prevents a slowing of the draft flow rate and actually slightly increases it, thereby best maintaining the temperature level.

The atmosphere inside the kiln during firing varies depending on many factors, including the nature of the fuel, temperature, and air flow, but generally it is composed of heated air (mostly inert nitrogen but, more significantly, 21 percent oxygen), fuel gas, combustion flame, and smoke. At lower temperatures most of the burning occurs at the surface of the fuel or nearby, but at higher temperatures there may not be enough oxygen to ignite all of the liberated volatile gases immediately, and carbon particles and burning may be delayed until the draft reaches further into the firing chamber or even outside the kiln (fig. 10). Unburned fuel as gas or particulate carbon (the visible element of smoke) can pass through the kiln and be lost, and in excessive conditions, that can reduce production efficiency. At higher temperatures some of the heat contained in the kiln walls is radiated back into the kiln, a condition known as the reverberatory effect, which is one reason the kiln needs to be insulated against heat loss, a secondary purpose of the buttress. At lower temperatures when the fire is moderate, there is usually sufficient oxygen for complete combustion, resulting in a so-called oxidizing atmosphere. At higher temperatures conversion of fuel to gas becomes more rapid, and the oxygen may be insufficient for the burning process. Within an oxygen-reduced atmosphere certain chemical reactions occur,² a circumstance used to advantage in coloring bodies and making certain glazes.

Firing a kiln to stoneware temperature imposes stress (thermal shock) on the structure, the degree of stress being related to the rate of temperature change. The process of gradually

² For example, in a reducing atmosphere iron as (red) ferric oxide (Fe_2O_3) may become (black) ferrous oxide (FeO).



Fig. 11. Inground kiln ceiling eroded by fusion (melting). Sawankhalok (Thailand).

heating and cooling a kiln is necessary for the successful firing of wares, but it is also beneficial to the longevity of the structure. Given occasional repair, the average life of a kiln is about thirty years, although when subject to very high temperatures (roughly 1300 degrees Centigrade), more aggressive thermal damage tends to occur. The two main outcomes of thermal damage are spalling (breaking away) and melting of the walls. In general, slag on kiln walls is a product of melting and consequent erosion (not accumulation of deposit) (fig. 11). Regarding historic high-temperature kilns nearing the end of

their usefulness, it is often found that the walls have eroded (melted) to half their original thickness (fig. 12).

Generally, firing technology in Southeast Asia employed a single firing of wares. Except in special cases, glaze was applied directly to the raw body of the newly potted artifacts by dipping, pouring, or brushing. Sometimes raw wares were given a white slip coating (usually to camouflage dark or rough clay bodies), then a coating of glaze. Those wares were then carefully placed into the kiln and fired to maturity. The European technique of a preliminary (bisque or biscuit) firing to remove physical and chemical water to better protect the glaze during a second firing was not often used in Southeast Asia. The declaration of two-stage firing in Southeast Asia, based on the finding of bisque-like sherds, is usually in error. Such finds are a consequence of immature or interrupted firing in which the wares reached bisque temperature and subsequent erosion removed loose glaze from the surface.³



Fig. 12. The walls of high-temperature kilns eroded by fusion (seen from above). The example shows a wall eroded to less than half its original thickness. (Myanmar).

Why China?

It seems that the inground crossdraft kiln evolved in China from the inground updraft kiln (Mino 1975:39–49, Yang and Zhang 1986:1–14). The notion of the crossdraft kiln as an invention independent of the updraft kiln is less probable, as the crossdraft kiln is such a complex concept that it is unlikely to have been invented without the experience of the updraft kiln, which preceded it by several thousand years. The invention may have been driven by the need to create more floor space in the firing chamber to provide a bigger area for setting glazed wares.

³ On lifting bisque-like wares during excavation of a stoneware kiln, the immature glaze can often be seen adhering to the adjacent sediment.

No records or research findings exist to explain why the crossdraft kiln should have developed in China and nowhere else, although the following speculation might be offered. Egyptian and Greek illustrations show updraft kilns as constructions on the ground although some lower part may have been below ground level. All further development of the kiln in the Western and Middle Eastern worlds grew from the concept of the ceramic kiln as a construction. In China stable loess soils could be exploited to create excavated inground spaces suitable for storage and habitation, and early Chinese updraft kilns were also dug into the ground (Kerr and Wood 2004:291, 294). Excavation and alteration of the internal space were simple, and apparently experimentation led to the development of the crossdraft kiln. This evolutionary process based on excavation in stable sediment had a major advantage. The internal space of the crossdraft kiln, which is predominantly the firing chamber, could be dug out as an enclosed space with a chimney cut upwards from the end opposite the firebox. No construction was needed as the entire kiln was completed by digging a hole in the ground. It follows that the potter's concept of a kiln was as an excavated space. It is that space or void that is operationally effective; the outside shape plays no part in the thermodynamics of firing.

The excavated (sculptural rather than architectural) free-form ovoid internal shape of early inground crossdraft kilns in China was a consequence of both its origins as a hole in the ground and the need to create a stable space in that context. This form of kiln was disseminated to Korea, to Japan as the *anagama* ("hole kiln"), and to the Inland Zone of Mainland Southeast Asia. The kilns introduced to the Coastal Zone were constructed on the surface and differed in shape from the inground kilns, with a greater width at the chimney end and a more rectangular ground plan. Given the developmental sequence of crossdraft kilns outlined above, it would seem an earlier kiln design was introduced into the Inland Zone and a later model into the Coastal Zone, yet the kilns there were established long before those of the interior. This anomaly may not be as confounding as it appears when the source of influence is considered.

All historic crossdraft kilns in Mainland Southeast Asia are of the single elongated firing chamber type, with a fire source at one end (as either a single or multiple firebox designed to burn wood fuel, including bamboo), and a chimney or vent at the opposite end. The Inland Zone kilns are more or less ovoid, whereas kilns in the Coastal Zone are more rectangular or trapezoidal and tunnel-shaped due to the use of a wide vent opening. Although general assumptions may be made, an overarching problem remains that affects our present ability to make more precise comparative judgments on production. While extensive literature exists on wares, little information has been published on origins, development phases, and relevant dating of kiln sites. Although many sites have now been discovered and in many cases kilns and related infrastructure excavated, no site has been thoroughly investigated and documented in respect to the means of production. Yet it is by such research that ceramic production in Southeast Asia (or elsewhere) will be more comprehensively understood.

Sawankhalok: A Case Study

At Sawankhalok (also called Si Satchanalai) in North-central Thailand, an attempt has been made to define one site in those terms. Study of that site has shown a sequence of

development from a simple inground kiln through a transitional form to one fully constructed of brick on the ground surface. The study explains changes in kiln design and the unlikelihood of any external influence concerning kilns, but to the contrary does show the certainty of influence in regard to artifact form and decoration. It also defines change to infrastructure, the impact of long-distance trade, and evidence indicating the end of the industry.

When the study began in the early 1980s, the large ceramic industrial site at Sawankhalok had been known for nearly a century. Pronouncements about its history and significance claimed it had been established by Chinese potters as an export industry, consisted of fifty or so kilns, was a subsidiary of another ceramic center at Sukhothai, operated for only a short period, and was destroyed by invasion—all of which are wrong. The study showed that its origins may have been due to activities of ethnic Mon people producing domestic goods for local consumption, that the site extended over an area of several square kilometers and held the remains of many hundreds of kilns, that it probably operated between the twelfth and seventeenth centuries, and that its gradual demise was due to commercial realities. The most important outcomes of the study were the determination of a technological sequence that defined at least four production phases, a probable change in the ethnicity of the potters, the recognition of an extensive infrastructure, and an understanding of the means of production over time (Hein 1986, 2001). In the absence of such information, interpretation can be misdirected.

The first kilns at Sawankhalok were small (three to four meters long) inground structures dug into the sloping bank of the Yom River and used to make domestic jars. This kiln type with a firing pit is found over a wide area and in addition to jars was used to fire stoneware bowls, dishes, stemmed bowls, oil lamps, toys, fishnet weights, plumb bobs, and some architectural pieces for Buddhist temples. Unglazed pieces with applied decoration and others with a dark green glaze over a white slip, often with sgraffito design, are of considerable technical and aesthetic merit. The phase is designated MON (Most Original Node), and the wares from that period are the only ones found in associated secondary cremation jar burials.

The next change at Sawankhalok brought new ideas about wares. It paralleled, and was integrated with, the final part of the MON phase. The MASW (MON Associated Stoneware) phase brought the introduction of white primary clay, black underglaze painted decoration, and celadon glaze applied without a slip, usually with incised decoration. MASW wares, which have particular potting mannerisms but duplicate MON ware types, were only fired in MON kilns together with MON wares, using existing setting and firing methods. This period demonstrates how influence concerning wares can be independent of firing technology. Attempts to identify the source of this influence have not been conclusive, but the celadon ware and underglaze painted decoration have some affinity with Vietnamese style (Brown and Sjostrand 2000:19; Hein 2007).

Although production remained primarily domestic, long-distance trade (including export) began to have an impact through pressure to improve quality and increase output. The TRSW (Transitional Stoneware) phase saw the exploitation of new design ideas and an expanded ware repertoire but little change to the means of production apart from the kilns. At this time a transitional form of the inground kiln was developed (fig. 13). The kiln was

made by excavating the lower half and constructing the superstructure, usually of raw brick but in some cases of clay. (At most other sites in Thailand, only clay was used.) New production nodes were established and the size of the kiln field expanded.

Then followed the final LASW (Later Stoneware) phase, dedicated predominantly but not exclusively to the production of export ware. This phase saw the production of the quintessential “Sangkhalok” (Sawankhalok) glazed wares for which the site is famous. It was a time of specialization, with specific sites concentrating on the manufacture of particular wares. Some groups of kilns specialized in making lidded boxes and vases, and others focused on architectural wares including sculpture. There were groups of kilns making large water jars, and another that produced ritual figurines. New glazes were developed, including monochrome white and brown and a bluish-green glaze that could best be produced by the last version of the crossdraft kiln at the site. These kilns were larger than earlier models (up to fourteen meters long) and had a relatively large firebox, high firewall (one meter or more), steep firing chamber (sixteen degrees), and wide circular chimney (two meters in diameter). These kilns were rebuilt over the ruins of others damaged by wear, such that some mounds contain the stratigraphic remains of ten or more structures (fig. 14). Radiocarbon dating of one sequence of ten superimposed kilns shows an operational span of three hundred years (Barbetti and Hein 1989). In one case a hydraulic quay system was instituted to allow wares to be loaded directly onto boats for transport along a dedicated canal that joined a major transportation system (Hein and Edwards 2000). Facilities of the kind would have been beyond the capacity and authority of simple potters and illustrate how management of the industry transferred from its original family base to one of corporate control in the hands of elite and perhaps foreign interests.



Fig. 13. Transitional kiln at Wat Don Lan, Sawankhalok, Thailand.



Fig. 14. The first surface kilns at Sawankhalok were established on the ground surface, and later kilns were built over the ruins of earlier ones, gradually creating a mound.

As a ceramic production center, Sawankhalok is not yet fully understood, but archaeological results indicate that the kilns of Sawankhalok were founded on the premise of local and extended trade to the north and west. Later the commercial imperative to contribute to maritime trade imposed the need for transportation several hundred kilometers southward along the Chao Phraya River system to the port of Ayutthaya. Study at Sawankhalok shows that partial observation of a site may not provide reliable evidence. Most historic ceramic production sites began in a small way (probably with one kiln) and grew and changed over time. Study of the full area

and depth of a site is needed to define its history with reasonable certainty. Without the relatively intensive examination at Sawankhalok the site would have continued to appear superficially as an old ceramic production center with a few kilns on artificial mounds, just like many others in Southeast Asia.

Presently, less is known of the other ceramic production sites in Southeast Asia but there may be sufficient information to support the bi-zone model. The following brief survey of regions will demonstrate the distinctions between the kilns of each zone.

The Coastal Zone (1) – North Vietnam

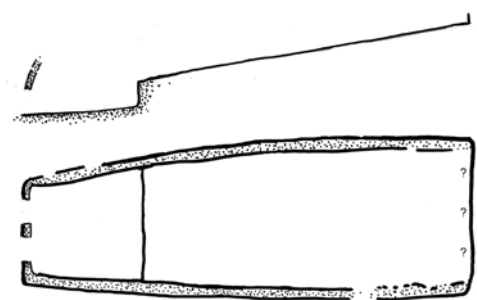


Fig. 15. Slab clay kiln at Tam Tho, Thanh Hoa province, North Vietnam. The firebox has a double firehole. The chimney form is unknown but appears to be ventlike.

The earliest datable high-temperature ceramic production site in Mainland Southeast Asia is at the village of Tam Tho in Thanh Hoa province (approximately 150 kilometers south of Hanoi), where today earthen mounds containing the remnants of surface kilns can be seen. Olov Janse (1941) excavated several of the mounds in the 1930s and described the kilns as “earthen-walled”; potsherds were often included in the mix for the clay construction. One kiln had a small part of the structure in brick. The kilns were rectangular or slightly trapezoidal in plan with the greatest width at the chimney end (fig. 15). The form of the chimney is unclear but appears to be vent-like, that is, wide and low. Observed today, the kilns are inclined with a step (firewall) separating the firebox and the firing chamber. Janse described the firebox as having two rather large fire openings, although it appears that the firebox was not divided into two chambers. The smallest of the kilns is 6.5 meters long and about 2 meters wide, but mostly the kilns are larger, measuring between 8.9 meters and 11 meters in length by 2.45 meters to 2.9 meters in width. Local tombs of the period were built of brick, which could have been used for kilns, but the Tam Tho kilns’ clay construction suggests that the potters understood a kiln to be something made of manipulated clay rather than brick. The remains of earlier kilns found below the uppermost ones indicated an extended term of operation. The main products were jars, vases, basins, and cups (often decorated with incised or stamped patterns and in some cases a greenish glaze) as well as spindle whorls, net sinkers, roof tiles, house models, and animal figurines.

On the basis of ware type and coins, Janse concluded that the operation of the Tam Tho kilns “obviously was carried on and directed by the Chinese” (1951:245) and probably operated from the second century A.D. into the Chinese period of the Six Dynasties (220–587). In the late Han dynasty (first through second centuries) northern Vietnam was a territory of China and the establishment of ceramic production at Tam Tho was probably an extension of a Chinese commercial concern located a little to the north. Janse noted that there were other kiln mounds in the area containing remains of kilns dating from the Han to Song (960–1279) dynasty and he also observed that there were

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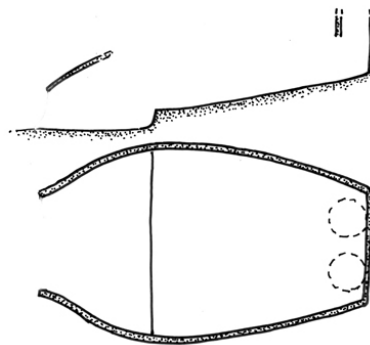


Fig. 16. Slab clay kiln with a double flue at Duong Xa, Bac Ninh province, North Vietnam.

Vietnamese potters still working (in the 1930s) who “seem to have perpetuated processes similar to those used by their predecessors at Tam Tho” (1951:145). Similar kilns (fig. 16) belonging to the late ninth to eleventh century recently discovered at sites such as Duong Xa east of Hanoi may well be part of a descendant continuum from Tam Tho (Nishimura and Bui Minh Tri 2004).

Ha Thuc Can and Nguyen Bich (1989:116) note that many “partly underground” kilns dating from the thirteenth century have been found at Lo Am Duong in Thanh Hoa province. This observation raises the matter of distinction between kilns partly dug into the ground (called transitional kilns in the Sawankhalok sequence) and surface kilns. There is a need for definition and I suggest that the essential difference is whether excavated natural ground is used as kiln “wall.” If the wall is completely constructed, the current term “surface” should apply (although a new term might be coined). Determining whether the kilns at Lo Am Duong—and for that matter those at Tam Tho—are a transitional or true surface type requires more detailed observation. In recent years many kilns belonging to the Ly and Tran dynasties spanning the eleventh through fourteenth centuries have been discovered between Hanoi and the Gulf of Tonkin in the delta area of the Red River (Tang Ba Hoanh 1993; Morimoto 1997:86). Due to erosion and other damage, only the foundations of the historic kilns remain, so that the complete form of the kilns has yet to be determined. Therefore the kiln drawing by Tang Ba Hoanh (1993:30) is probably fanciful, but his information on setting methods and kiln furniture, which includes saggars, cylindrical supports, and spurred and plain disc supports or ring supports, is helpful.

It is uncertain whether the immediate heir of Tam Tho is to be found at one of the known Hanoi region sites or at another as-yet-undiscovered northern site, but it is certain that if one developed from the other, similarities in technological attributes will be evident. While there are similarities between the kilns of Tam Tho and those near Quy Nhon in Dinh Binh province on Vietnam’s central coast, the differences are so great as to suggest either one or more intermediate links. There is also a possibility of direct influence from China to Central Vietnam that was a separate event of influence to that of Tam Tho, but if so transfer from a technologically and possibly geographically related source is likely.

The Coastal Zone (2) – Central Vietnam

Similar to other cases, the so-called Cham wares were known long before the discovery of their production site. On stylistic grounds the high-temperature glazed ceramics in the region of Vietnam controlled by Cham principalities are thought to have been made from the eleventh century during the days of the Vijaya kingdom until the sixteenth century. Kiln groups were found in Binh Dinh province in the early 1990s, and excavations were conducted soon after, the most recent being in 2002. The kilns were built on high artificial mounds in the midst of rice fields on the banks of the navigable Con River and close to the old sea port at Quy Nhon.

Generally the excavated kilns are elongated and more or less rectangular in plan, usually narrowest at the firebox and slightly wider at the vent. The kilns increased in size over time from about nine meters to fourteen meters in length. Of the five known sites at the villages of Go Sanh, Truong Cuu, Cay Me, Go Hoi, and Go Ke, two have been excavated. At Go Hoi the kilns are built of clay, but at Go Sanh the later kilns have sections of their walls made of clay-plastered saggars, although it is unlikely that the upper dome (which does not survive in any of the excavated kilns) could have been made in the same manner. A number of apertures in the back (vent end) wall at floor level, in some cases made by punching out the bottoms of saggars, boxed by a closing wall, formed a vent system (fig. 17). The existence of the vents as an exit for the draft suggests that no chimney as such existed and that the firing chamber ceiling at that point was low. A side door usually located in the middle of the right-hand firing chamber wall was apparently used for loading and unloading the kiln. There is a firewall with a height of about fifty centimeters.

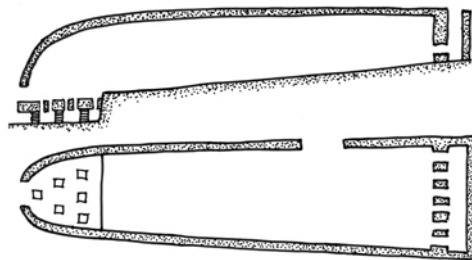


Fig. 17. Clay slab kiln at Go Sanh, Binh Dinh province, Central Vietnam. The construction is slab clay, with saggars forming some parts. The nature of the firebox is conjectural. Six short pillars in the firebox may have supported a grate on which the fire was set. A loading door is located on the right-hand side. Six apertures lead to a wide vent for the exit draft.

The firebox of Go Sanh Kiln 1 has six pillars arranged in a triangle, and a similar feature was found in each of the other uncovered kilns. In their report the excavators described the pillars as “flame dividing,” but with the primary purpose of providing support to the ceiling of the “combustion chamber” (firebox). However, this unusual feature was certainly not related to roof support: Why should a means of multiple support be needed in a part of the kiln with a span of little over a meter, when the far greater span of the firing chamber of up to 2.8 meters apparently did not require any support at all? On the evidence presented in three reports of text, drawings, and photographs (Yamamoto, Hasebe, Aoyagi, and Ogawa 1993; Aoyagi 1997; Nguyen-Long 1998; Aoyagi and Hasebe 2002), the pillars appear to have supported a suspended perforated floor to provide a channel for air to pass up through the fire set above it. The consequentially reduced space suggests that coal, with its higher calorific value, or a coal-timber mix may have been used as a fuel. If so, these are the only historic kilns in Southeast Asia to have revealed such a feature and firing technology.

A variation on the general form of the Go Sanh kilns was found in the lowest kiln in a stratigraphic stack of three. The kiln is only about seven meters long, is made entirely of clay, and has the unusual feature of three L-shaped flues that directed draft upwards. The structure may represent a period of experimentation and development, although Aoyagi and Hasebe (2002, 39) claim similarities to China’s Gongxian kilns of the Sui (581–617) and Tang (617–907) dynasties and allow the possibility of direct influence from China. Therefore, it may be significant that the meaning of the name Go Hoi is “village of the foreigners” and that the settlement is said to have been populated by Chinese, which supports the notion that production occurred “under the influence of Chinese ceramics if not the movement of

Chinese potters” (Aoyagi 1997).⁴ Nguyen-Long (1998) points to evidence suggesting that Chinese had a role in the development of glazed stoneware in this locality. She suggests that the kilns studied so far bear signs of assimilation consistent with a gathering of potters from different ethnicities, and that comparative analysis shows that northern Vietnamese sites did not play a part in establishing production in Central Vietnam. Unfortunately the author provides no detail. Furthermore, the consistent form of the kilns in Vietnam compared to the range of Chinese regional kiln types of the time imposes the need for caution in ascribing external influence other than from Chinese kiln sites using similar kilns.

Coastal Zone (3) – Angkor Period of Cambodia and Northeast Thailand

High-temperature ceramics produced during the Angkorian kingdom—which are commonly known as Khmer ceramics but might be more accurately referred to as Angkorian ceramics—have been recognized since the early work of Aymonier (1901) and Groslier in the 1950s, who noted the probable existence of a production site on Mount Kulen. This suggestion has been realized with the discovery over the last decade of kiln groups on Mount Kulen at Anlong Thom; nearby on the plains at Tani, Sar Sei, Teuk Leck, Khnar Por, and Bang Kong; and to the north at Kamtout (Rooney 1999; Tabata 2006; Darith et. al. 2008). The kilns are 8 to 9 meters long, 2.3 meters to 2.8 meters wide, and have a single row of columns along the center line of the firing chamber to support the dome (figs. 18, 19). Kilns have recently been located in Banteay Meanchay province, along the route of the Angkor-period road that runs from Angkor through Buriram province in Northeast Thailand to the important provincial city of Phimai (Darith 2006). These Angkorian ceramic production centers indicate an extensive ceramic industry serving a regional population. One other kiln site at Cheung Ek in Kandal province, south of Phnom Penh, appears to belong to the time when the Khmer capital had moved south from Angkor. These discoveries have all occurred in the last few years, and the finding of more kilns is anticipated.

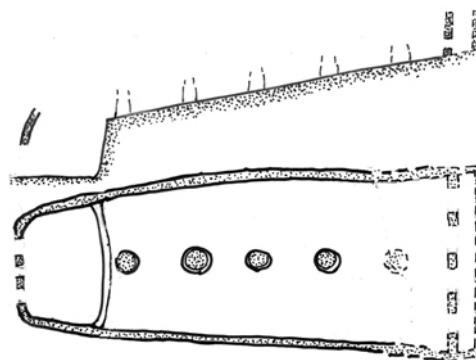


Fig. 18. The firebox of a kiln at Tani, Siem Reap province, Cambodia, has a double firehole and a secondary air aperture. Five columns in a single row along the center line of the firing chamber were used to support the slab-built dome. All known Angkor-period kilns in Cambodia have such columns.

Until recently archaeological study of Angkor-period kilns focused on those at Ban Kruat, Ban Baranae, and other production sites in Buriram province as well as a few in Surin and Sisaket provinces in what is now Northeast Thailand. These kilns are thought to date from the tenth through the twelfth centuries (Groslier 1981:31; Suphat and Sirikun 1989:80). Findings have provided consistent evidence of small clusters of kilns built on artificial mounds, usually within the ubiquitous flat rice-field landscape. Excavation of the Nai Jian

⁴ A report on excavations in 2002 of the Binh Dinh kilns at Go Hoi, led by Prof. Trinh Cao Tuong of the Vietnam Archaeological Institute and Miriam Lambrecht of The Royal Museums of History and Art, Belgium, has yet to be published.

and Sawai kilns at Ban Kruat revealed clay wall structures built on an artificial mound and inclined at about fifteen degrees. However, the form of the Angkorian kilns of Buriram is not entirely certain. Published reports by the Fine Arts Department (Suphat and Sirikhun 1989) and diagrams and models in on-site museums show a long (15 meters), narrow (about 1.5 meters) kiln built of clay with a single firebox and a chimney. This analysis is repeated by most authors, but if correct there must have been several of the kilns parallel to and in contact with each other. No other example of such contiguous kiln layout is known. Repair or replacement of any one unit would be extremely difficult, yet the ruins reveal evidence of several reconstructions.



Fig. 19. Tani Kiln A6. Photograph reproduced courtesy of Sugiyama Hiroshi.

An alternative interpretation that arguably remains consistent with the archaeological evidence is that the kilns were between three and four meters wide, with up to three parallel fireboxes and a wide vent system at the upper end of the firing chamber to allow the exit of the draft (fig. 20). The vent extended straight across the upper width of the kiln, but as the upper part of the kiln mounds is usually eroded, detail is lacking. Given the inherent weakness of clay construction over such a great width, internal support would have been essential. This explains the remnants of lengthwise rows (one or two per kiln) of columns to support the firing chamber dome. (The presence of these columns is not satisfactorily explained by the Fine Arts Department report.) Potential structural weakness also accounts for the dividing walls separating the multiple fireboxes, since they would serve to provide roof support at that part of the kiln.

In interpreting the form of the Angkorian kilns in Buriram province, comparison should be made to the kilns operating under the same polity, during the same period, and producing the same wares in a similar physical context at Angkor. The notion that the kilns should be radically different in form is controversial. Furthermore, the suggested alternative form of the Buriram kilns and the known shape of the kilns near Angkor show a structure generally similar to those in Binh Dinh province—that is, a rectangular plan, multiple fireholes,

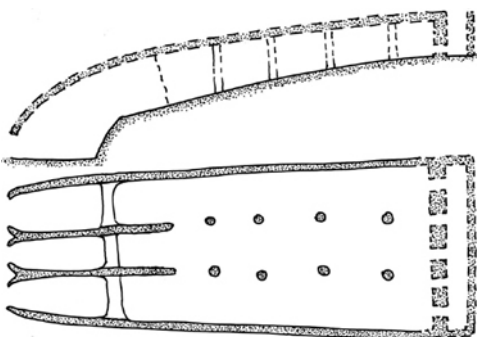


Fig. 20. A conceptual sketch of Sawai kiln near Ban Kruat, Buriram province, Thailand, shows a wide kiln with columns supporting the firing chamber dome and multiple fireboxes (the divisions of which also support the roof).

essentially clay construction, and a vent system instead of a chimney. The main differences are greater kiln width and consequential use of pillars to support the roof found in Angkorian kilns, and loading ports in the case of Binh Dinh kilns. Depending on the outcome of further research, some difference may also exist in relation to the firebox.

The close resemblance of the Angkorian kilns to those of Vietnam suggests that the kilns of the Coastal Zone belong to essentially one technological tradition. Those of the rest of ceramic Mainland Southeast Asia, to which we now turn, are of a distinctly different tradition.

The Inland Zone (1) – Burma (Myanmar)

The earliest evidence of glazed ceramics produced in the Inland Zone is earthenware in Burma, where a ninth-century date is given to the Ngakywenadaung pagoda in the early Burmese capital of Bagan (Pagan), which has lead-glazed bricks on the outer surface. Chinese records of the same century refer to a Burmese city with glazed brick walls (Luce and Chen 1924). Other early Burmese lead-glazed ceramic wares include architectural fittings and plaques on datable temples and domestic pottery found in habitation areas from Bagan in the north to Bago (Pegu) in the south. In both cases the kilns that fired those wares have not been found, so the question arises of what the kilns were like and where the technology originated.

Another problem in attempting to determine the origin of kiln-fired glazed ceramics in Burma is that nearly all of the known ceramic production sites have been discovered in the last decade or so, and there is a high probability that many more will be found when access is granted to “sensitive” areas, particularly in the Shan, upper Sagaing, and Kachin states in the north and in the south below Bago. Such finds may radically change assumptions based on present knowledge.

There are signs of early updraft kilns of unknown purpose at the old Mon capital of Bago; a number were found at Sayohpho, a pottery village that also made smoking pipes to serve Inn Wa, an important northeastern Shan city (Hein 1997). Signs of old updraft earthenware kilns have been reported near Sulamani temple at Bagan (Hudson 2004). Seven updraft furnaces at Bagan that were previously thought to be earthenware kilns have been shown to have manufactured glass beads (Hein 1996:2003). Although bonfiring is still the most common means to make earthenware, the updraft kiln has also been used for the same purpose.

Unfortunately, most of these sites have not yet been thoroughly investigated, and no firm identification or chronology has been established for them. However, there is no indication in Burma or anywhere else in Mainland Southeast Asia that the updraft kiln evolved into the crossdraft kiln. Nor is there evidence, assuming both were introduced, whether the updraft kiln preceded the crossdraft or, if so, where it originated. There is little doubt that the crossdraft kiln came from China, and it is possible that the updraft kiln did as well. However, the updraft kiln was also known in India and may have been introduced in turn from the Middle East. Its introduction to Burma and the rest of Mainland Southeast Asia may have occurred as part of the acculturation that occurred from the intercourse with India during the first millennium, to be adopted along with Indian concepts evident in much of the repertoire of Burmese art, including ceramics. There may be another factor supporting this conjecture: Most of the known early updraft kilns in Southeast Asia appear to be in Burma and western Thailand.

Historic inground crossdraft kilns have been found at several sites including Bago and Myaung Mya, but none have been dated and the time of their earliest use is unknown. The known inground kilns were specialized to produce domestic rollers and grinding platforms that were stacked in the kiln in piles (bungs) for firing. To allow the most efficient setting, the kilns were dug with vertical sidewalls and an almost flat ceiling to give the firing chamber a nearly rectangular cross section (fig. 21). In these kilns the acutely inclined firing chamber floor was made horizontal at the back of the chimney, a feature that suggests firing maturation was judged by looking down the chimney to observe how much shrinkage had occurred in a row of wares placed on that shelf (as potters in Laos and Northeast Thailand still do today). Another distinctive aspect of these inground kilns is that the firewall is curved toward the firehole, an evolutionary attribute explained above. An unusual feature is that the firebox floor is inclined downwards toward the firewall, probably due to the need to deepen the firebox to provide more fuel and combustion space while leaving the firehole in the same position to maintain draft characteristics.

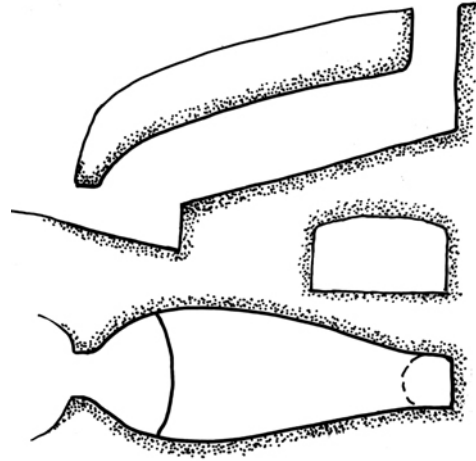


Fig. 21. Inground kiln at Myohaung, Myaung Mya, Burma (Myanmar). As in many Burmese kilns, the firebox floor inclines toward the firewall and the firewall is curved.



Fig. 22. Large mound of many kilns at Nophotaw, Lagumbyee district, Bago province, Burma (Myanmar).

With perhaps one modern exception, there are no known transitional kilns in Burma, and their absence raises questions about the origin of surface kilns there. A related factor may be that all known surface kilns are built of brick (none of clay). Unless evidence to the contrary is found, it is reasonable to assume the surface kiln was a technological import rather than a local innovation.

Surface crossdraft kilns constitute the most numerous and most widespread kiln type in Burma. They are found in sites across the country and are concentrated near major historical population centers. The ubiquity of known and informally reported ceramic production sites in Burma suggests an extensive history, and on the basis of present knowledge ceramic activity in Burma employing crossdraft kilns seems to have been at least as extensive as elsewhere in Mainland Southeast Asia, a circumstance only recently realized.

Hundreds of brick-built surface crossdraft kilns have been found at many sites in the Twante area, more than one hundred in the Lagumbyee district of Bago (fig. 22), and one at Myaung Mya. They are also found along the Arakan Yoma mountain range and as far north as Mrauk-U in Arakan state, where colorful lead-glazed earthenware was made (Hein 2003). Kilns have also been reported north of Bagan at Pakhangyi (Dr. Aung Bo personal comment). A parent site of the modern jar kilns at Chaungmyaung near Shwebo is located a few kilometers further up the Ayeyarwady (Irrawaddy) River, at Pan Pin Swan. Kilns have been reported near Keng Tung and other sites in the northeast Shan state. There is a high

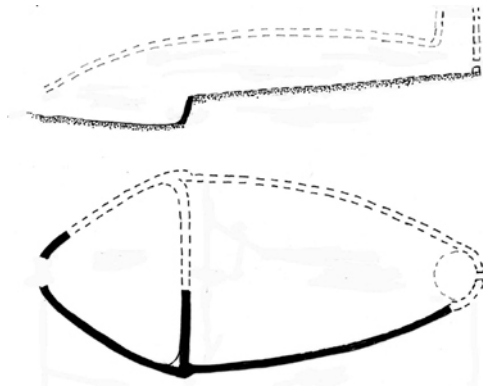


Fig. 23. Kiln at Lagumbyee, Burma (Myanmar). Note the pointed firebox, the downward inclined firebox floor, and the aperture in the rear of the chimney.

twelfth-century earth-walled town near Bago, the capital of the Mon kingdom (although the kiln itself has not been dated). The kiln is generally like most other surface kilns in the Inland Zone, ovoid in shape, about 10 meters in length, 4.5 meters wide, a single firebox with a fixed firehole, a straight firewall, inclined firing chamber, and a cylindrical or slightly conical chimney (figs. 23, 24). One of the peculiarities of the kiln in the Lagumbyee area and of others at sites at Twante is a narrowing of the firebox toward the firehole, giving the firebox a rather triangular shape in plan. As in the inground kiln at Myaung Mya, the floor of the firebox slopes toward the firewall, an attribute that raises the question of relationship.

Another oddity is a hole about twenty-five centimeters in diameter through the back of the chimney near the floor, which approximately aligns with the ground level outside—the purpose of which was possibly to allow test pieces to be drawn out (although none have been found) or simply to check the progress of the firing visually. A similar aperture in the Myaung Mya kilns at fifty centimeters is large enough to have been used as a passage for wares. This feature, which may be common in Burma, is not known elsewhere in Southeast Asia. In common with most surface kilns in the Inland Zone, these Burmese kilns were built of large raw bricks about eleven centimeters thick and twenty-three centimeters wide. Kilns of the same type excavated at Kangyigone near Twante are larger and each has a pair of square columns to support the firing chamber dome near the firewall (Daw 1999), but it is not known whether the columns were built as part of the kiln design or were added when problems with the dome were experienced (fig. 25). This is the only known example of support columns in the Inland Zone. These kilns, like those of Lagumbyee and

probability that crossdraft kilns will also be found at Martaban in the south (Yule and Burnell 1903, Gutman 2001), and other kilns have been documented in Yangon (Orr 1988). Crawford (1829) and Singer (1990) report old and contemporary ceramic production sites at other places in the north. Many more kiln sites are yet to be found, including those that made the famous green and white wares and the underglaze painted wares. In fact, it appears this region has the greatest number of ceramic production centers.

Only two surface-type crossdraft kilns have been excavated. One is at Lagumbyee, a



Fig. 24. The edge of the lower wall of the Lagumbyee kiln is rounded where the unhardened section of the large raw clay bricks later eroded.



Fig. 25. Kiln with pillars at Kangyigone near Twante, Burma (Myanmar).

other sites, made ash-glaze green (celadon) and brown wares.



Fig. 26. Excavation at Myaung Mya, Ayeyarwady (Irrawaddy) River Delta, Burma (Myanmar).

The second brick-built surface crossdraft kiln to have been excavated is located at Myohaung near Maung Mya in the Ayeyarwady River delta, one of the several villages containing inground kilns, although no form, product, or synchronous relationship between the two was apparent (no ware from either site was found in association with the other). The kiln was used for making medium-size water jars of unglazed stoneware and bowls and animal models with brown ash glaze (fig. 26).

The kiln was built of bricks about half the size of those used at Lagumbyee, and is about eleven meters long by three meters wide. A large door-like aperture at the front of the permanent structure was used for loading and unloading the kiln, then closed with a temporary wall of brick, leaving a number of fireholes in vertical alignment. Most of the jar kilns presently operating throughout Burma, where the firing process can be observed, employ this system (fig. 27). Initially, fuel is fed through the lowest firehole, which provides the greatest draft pressure (needed early in the firing). As ash accumulates in the firebox, the lower firehole is closed with brick and clay and fuel is fed through the next highest opening, this process continuing until, near the end of the firing, the uppermost firehole is used. The value of this method is that accumulated ash need not be withdrawn from the firebox during firing and the draft pressure can be progressively decreased as the temperature rises (allowing maximum value from the reverberatory process). The design and construction of this kiln type suggest it belongs at the later end of the evolutionary sequence.

The pinnacle of development seems to be represented by the huge kilns of Twante designed to produce the most iconic of Burmese ceramic wares, the large, lead-glazed, narrow-based so-called “martaban” water jar that can be seen all over the country. Partially buried in the ground along the roof perimeter of houses, they are used to catch and store rainwater. Use of the foreign term “martaban jars” (martabani, martabana, montaban, matavaana) to identify large water jars traded from Martaban (Martavan), near Moulmein in Lower Burma, was common between the fourteenth and nineteenth centuries. No kilns have been found in the Martaban area, however, and the jars were probably made at Twante and other sites (see Yule and Burnell 1903:560).

The largest of the complete Twante jar kilns measure eleven meters long, five meters wide and 4.7 meters high, and the front opening (before being closed as above) is more than two meters wide and high, sufficient to conveniently admit the largest jars (fig. 28). The raw clay bricks used to construct the kilns are



Fig. 27. Kiln at Mudon near Moulmein, Burma (Myanmar), showing uppermost firehole of three being used.



Fig. 28. Twentieth-century jar kiln at Twante, Burma (Myanmar), with a firing chamber nearly five meters high.

about the same size as for the Lagumbyee kilns, and the lower sides of the kiln are solidly buttressed with sand and ceramic debris within a surrounding wooden wall. Kilns still operate, and older kiln ruins are evident at the site.

Another glazed stoneware production site that used surface brick-built crossdraft kilns of the Lagumbyee type is located along the Arakan Yoma mountain range at Ngaputaw on the Bassein River and Kaluktaung, where green ash glaze stoneware bowls were made. At Mrauk-U in Arakan state the kilns are similar but lead-glazed high-fired earthenware was produced. Small U-shaped bowls constituted the main form observed in the kilnsite debris, but colored tiles and floral wall pieces and a medium-size jar with blue pictorial decoration over a white lead glaze in a local museum attest to wider local production. Although lead-glaze kiln-fired ceramic ware, especially temple plaques, was apparently made at Bago, and although large amounts of lead-glazed bricks, architectural fittings, roof tiles, and temple plaques at Bagan indicate local production, Mrauk-U is the only confirmed production site of this ware type.

The inground and surface kilns described so far account for most of the historic crossdraft kilns in Burma. However, there are some kilns operating today at Kyauk Taing (there is no current evidence they existed historically), situated at the southern end of Inle Lake, that are similar to inground and transitional kilns of Thailand and Laos (Reith 1997). Originally the kilns may have been excavated, but according to the potters, the domes are repaired from time to time with (manipulated) clay (fig. 29). The almost continuous floor and consequent lack of firewall other than a slight inclined curvature suggest a very early form of crossdraft kiln that may have survived over time. In principle the kiln form is a transitional type, but evidence for historic development has not been found in Burma.

The form of surface crossdraft kilns in Burma varies in different parts of the country and apparently over time, but the patchwork of current information makes assessment difficult. Another complication not found elsewhere is the extensive but separate use of both lead and alkaline (ash) glazes. No production site is known to have used both lead and ash glazes simultaneously, and individual sites using one or the other are dotted across Burma. Earthenware, such as large water jars and many domestic wares (especially containers) is usually coated with lead glaze, as is the case with temple plaques, tiles, and fittings. Tin-opacified lead glaze on earthenware is a special product class of high aesthetic order (arguably representing the best of Burmese ceramics) for which no production site has yet been confirmed. The type of kiln used to fire lead glaze wares from about the ninth century is not known, but crossdraft kilns have been employed for at least the last century or so. Ash glazes only appear on stoneware of a kind reminiscent of fifteenth-century Sawankhalok wares—mainly plates, bowls, and small jars—and are only associated with surface crossdraft kilns, which represent the greatest number of kilns in Burma. One further mystery has yet to be solved: Which kiln types



Fig. 29. A hybrid kiln at Kyauk Taing, Central Burma (Myanmar). It appears the kiln was originally dug as an inground type then later repaired by replacement of the dome (technically making it a transitional type).

and methods were used to glaze the sandstone temple plaques and fittings found at Bagan?

The Inland Zone (2) – Laos and Northwest Vietnam

Various culturally and ethnically distinct minority societies inhabit the northwest highlands of Vietnam, including the Tai, whose ancestors are thought to have belonged to the same people who from around the second century migrated westwards to become the Lao, Thai, and Shan of Burma, some even reaching as far as Assam. Today Tai Dam (Black Thai) in the village of Muong Chanh, Mai Chai district, Son La province, fire jars in crossdraft kilns dug into the ground (Huu Ung 1987). The kilns are dissimilar to those of the Coastal Zone but appear to be technically coherent with the inground kilns of the Inland Zone. Further study of the form and history of these kilns is required to determine their place in their order of kiln dissemination in Southeast Asia.



Fig. 30. Excavation at Ban Xang Hai, near Luang Prabang, Laos. Inground chimney openings show at the ground surface to the right. (transitional type).

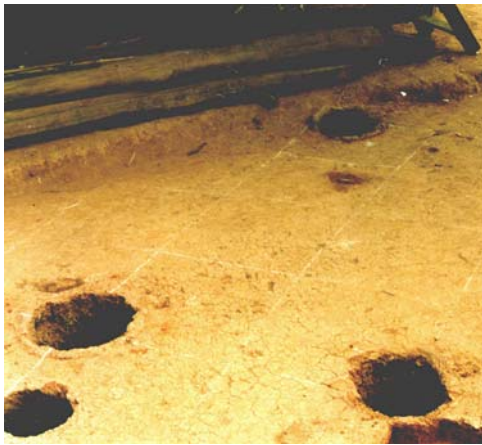


Fig. 31. Excavation at Ban Xang Hai. The same inground chimney openings seen from above.

Advice from a villager led to the discovery and excavation of inground kilns at Ban Xang Hai on the banks of the Mekong River about twenty kilometers north of Luang Prabang. The excavated kiln was small: four to five meters in length, a little over two meters wide, ovoid in shape, and with a small diameter firehole and round chimney of about forty centimeters (figs. 30, 31). The kiln has a medium (thirty centimeters) offset between the firebox and the firing chamber, and the cross-section of the firing chamber is semicircular—slightly rounded at the junction of the walls and floor—reflecting the hole-in-the-ground kiln concept. A strange stratigraphic circumstance exists at the site, where the remains of some kilns exist near the surface and others are at a lower level. It appears that crowded conditions led the potters to remove a meter or so of the ground to allow new inground kilns to be dug under the ruins of earlier kilns. Only one of the lower kilns at Ban Xang Hai was (partly) excavated and appears to be a similar type, although a little smaller.

About twenty kilns were recorded at the site, but surface evidence indicates the presence of many more. Wares found in association with the kilns include unglazed wide-mouth bowls of various types and jars of many sizes and shapes, from small to sixty centimeters high, with incised and applied decoration, including the spiral “recumbent S.” The most common form is a tall, proportionately narrow flared-mouth type distinctive of Lao jars. Fermenting jars

with double mouth rims were common in the assemblage. Lugs on some larger jars and bowls were attached by penetration of the jar wall. Mixing mortars, fishnet weights, spinning whorls, and plumb bobs are common, and a few animal models were found. Some flared-mouth, brown-glazed jars were found at the site—some as wasters which usually indicates local production—but there was no indication they were made in the excavated kilns. Included in the finds were a few sherds of Sawankhalok celadon and Vietnamese brown ware (of the type illustrated by Young et. al. 1982:77, plate 38). Another interesting aspect of the Ban Xang Hai site is the discovery of large numbers of prehistoric stone tools, bronze artifacts, and circular stone amulet pieces, mostly discovered at the river edge as the bank underwent erosion. (The manufacturing site of the amulets was located in nearby hills.) Many tobacco smoking pipes could be seen on the surface, most recognizable as made at Si Sattanak (see below) but some as a Luang Prabang type (Hein 1997). There was no evidence of pipe manufacture (no wasters or stratigraphic finds, etc.) at the site. Visitors from closer to the Chinese border reported ceramic deposits and possible kilns near their village.

A village called Ban Tao Hai (“village of jar kilns”), shown on a map of the Luang Prabang environs, warranted investigation. On a steep slope, inground bank kilns were found in association with sherds of unglazed grey jars and architectural roof tiles and finials. Also marked on the map was a site called “Ban Sangkhalok,” which has particular meaning as an earlier name for Sawankhalok in Thailand and as the vernacular name for Sawankhalok ceramics (Vickery 1986:9; 1990:25). Therefore, this author believed coincidence was possible. Green-glazed jar sherds with impressed geometric and animal designs of a known type without provenance were found on the ground surface throughout the village. Although nobody in the village knew of any kilns, persistent search led to the discovery of a chimney about one meter in diameter and with glaze on the inside.

Although ceramic jars, bowls, smoking pipes, and architectural wares were long known at the village of Si Sattanak, also known as Ban Tao Hai, located three kilometers south of

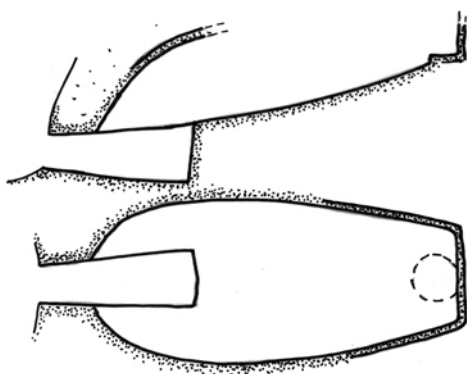


Fig. 32. Transitional kiln at Si Sattanak, Vientiane, Laos, with an unusual trench firebox. The upper dome and chimney were made of slab clay. The small step in the chimney contained a row of jars used to judge firing maturity.

Vientiane in Laos, kilns were not recorded until Christian Velder (1965), administrator of the local Lao-German technical college, and Thai professor Sanguan Rodboon (1983) described finds and kilns at that location. Velder noted bowls, jars, and smoking pipes and referred to bricks that might have belonged to kilns.⁵ During construction of the college in 1970, seven kilns were found in addition to large amounts of ceramic wasters. Sanguan attended the excavation but did not publish his observations until later (Sanguan 1983). He described the kilns as approximately six meters long, 2.6 meters wide, with the dome above the “old” ground level, and a round chimney of forty centimeters diameter. He said that the roof was thirty centimeters thick

⁵ Such imprecise references are frustrating to the researcher, as the distinction between architectural and kiln brick is usually quite easy to determine due to a burned and often glazed face of the latter.

and the wall was built of brick with “clay outside,” a rather odd description and perhaps in error, as the inner slagged clay slab wall can be mistaken for brick. Finally, he said that the floor was sloped and the “bottom” (apparently referring to the firebox) was lower, with a width of 1.2 meters and length of 1.3 meters. The “mouth” (firehole) was fifty centimeters wide, and bricks around the mouth measured thirteen by twenty-four by four centimeters.

This description was similar in dimension to the kilns excavated by an Australian-Lao team in 1989 and 1990 (Hein, Barbetti and Thongsa 1992), except the kilns were transitional and half buried in the clay-rich ground, and the dome of the firing chamber chimney was built by the (manipulated) clay method, using spoil from the digging of the lower section. No bricks were found as part of the kiln or in association. The form of the chimney could not be determined with certainty, but pieces of wall found among the debris suggested a circular shape. As Sanguan thought, these kilns are similar to transitional examples found in Lan Na, the northern area of Thailand, except for two features: first, a raised, step-like ledge at the base of the chimney that supported the jars used to assess firing maturity, and second, a trench-like firebox (fig. 32). The trench firebox is not found elsewhere so its development is unknown; however, it may be an extension of one solution to a long-existing problem.

As the firebox enlarged and deepened to produce a greater amount of heat in the search for higher temperatures, the firewall became wider and higher. Consequently, the increased pressure exerted by the adjacent earth mass often caused the firewall to weaken and slowly collapse over repeated firings. To make a running repair, “benches” were applied to each side of the firebox to buttress the firewall (fig. 33), but the enduring solution was to build a strengthened wall from brick instead of the natural sediment. The firebox trench in the Si Sattanak kilns may have been a continuation of the bench concept, although the reduced space for the fire limited the capacity to generate heat, a condition suggested by the slight amount of glazing (fusion) of the inner kiln wall surface. However, the glazed ceramic product attests that the outcome was satisfactory.

Bowls and jarlets with distinctive triangular-pattern stamped decoration and a weak green ash glaze, along with unglazed medium-size flared-mouth jars (of normal proportions, i.e. not narrow as the northern Lao type), roof finials, lamps, and bowls used to dampen or starch silk thread in the weaving process were the main products. Smoking pipes were also common, typically made without a glaze but in some cases applied with the same translucent glaze found on other wares (Hein 1989).

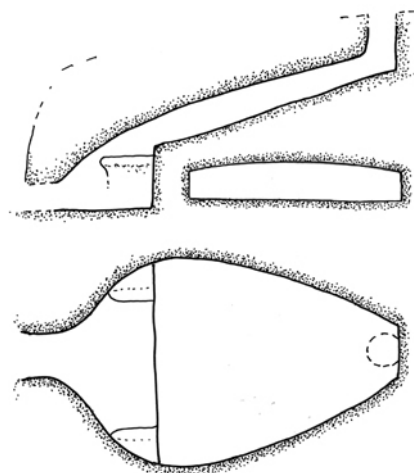


Fig. 33. Inground kiln at Ban Nong O, Sawankhalok, Thailand. The firing chamber section is more than 3.5 meters wide and only fifty centimeters at the highest point. Side benches were added to the firebox to support the high and wide firewall. The protuberance of the firebox was a consequence of the thick wall at the only point where a freestanding wall was required.

The Inland Zone (3) – Thailand

The ceramic kilns of Thailand have been observed for more than a century and to date are the most extensively studied in Southeast Asia, a reflection of relatively stable political conditions and the consequential access and amount of applied research. Leaving aside the Angkorian kilns of Buriram province, which belong to the Coastal Zone, the pattern of distribution in Thailand displays one salient feature: The greater number of sites is found in the north of the country, with density declining towards the south. It is clear that production was located to serve inland agrarian populations, either concentrated in cities or clustered in peripheral villages, especially along the rivers that constituted the principal transport routes. The south may have been sufficiently supplied by ceramics arriving through existing maritime trade, but another reason might have involved the political and cultural differences between the north and south inhibiting diffusion of the technology.

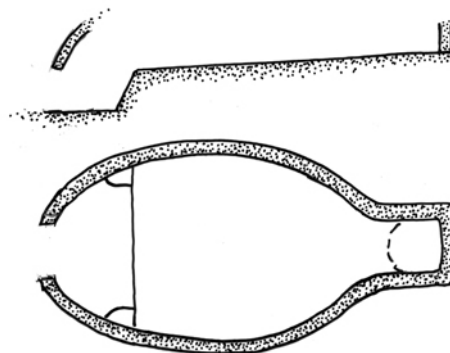


Fig. 34. Transitional kiln at Ban Bang Pun, Suphanburi province, Thailand, with slab clay walls. Since the small size of the firebox should not have threatened collapse, the side benches may have been a vestigial.

The time of foundation of Thai kiln sites (as distinct from dates during the term of production) is uncertain even to the nearest century, primarily due to the lack of field archaeology and scientific investigation. In some instances relative dating has been established for wares found in trade contexts, but in most and perhaps all cases domestic production began long before extended trade. Nearly all of the kilns furthest north in Thailand are either inground or transitional types, and evidence of independent change beyond that stage of development in that area has yet to be demonstrated.⁶

One apparent anomaly to the northern concentration of kiln sites does exist at Ban Bang Pun near the city of Suphanburi, where extensively eroded remains of what appear to be clay transitional kilns were found on the left bank of the Suphanburi River (fig. 34). The kilns produced high-shouldered, flared-mouth jars similar in form to those of many other Thai sites but with stamped decoration similar to that found on Dvaravati (Mon) earthenware pottery of Central Thailand (Jaruk 1987). (Suphanburi lies in the center of the Mon region.) In particular, animals and human images of a processional character are similar to those found on Mon wares from other sites (Bronson 1976, Phasook 1985) and bear a very strong likeness to clay temple tiles, stucco decoration, and stamped pottery in Burma and to Angkorian carved stone frieze style, both an influence from India. If the Ban Bang Pun kilns

⁶An assumption by the author that the northern kilns were probably the first to be established in Thailand was threatened by the claimed discovery of a crossdraft kiln in a ninth-century context at Ban Krabuang Nok, Nakorn Ratchasima province, in the Northeast (Phasook et al. 1989). If true, the find would have revolutionized the history of Thai ceramics, but that claim was wrong. No such kiln exists.

are transitional as claimed, in terms of development they would be sequentially later than MON kilns at Sawankhalok, but sherds of Suphanburi stamped ware were recovered from the context of MON kilns at Sawankhalok, which proves that Ban Bang Pun was in operation at the time of the first phase of Sawankhalok. In the study of kiln sites, such apparent contradictions do arise. In this case they may be explained by an error in the definition of the Suphanburi kilns or by the possibility that the transitional kiln had been developed at Suphanburi before being invented or adopted at Sawankhalok. The Ban Bang Pun kiln site is the only one located within

convenient reach of the coast, which could indicate trade by sea, although shipwreck finds of Suphanburi jars are rare and suggest crew use rather than export.



Fig. 35. Inground kilns excavated at San Kamphaeng, Thailand.

Old Lan Na kiln sites within the compass of the upper Chao Phaya River system include those at Kalong, Wang Nua, Nan, Phayao, and San Kamphaeng (fig. 35), all of which produced a range of celadon and underglaze painted wares of high aesthetic quality.⁷ Many bear a close resemblance to MON wares of Sawankhalok, particularly those of Phayao, where inground kilns have been recently excavated (Sayan 2007). Kilns at Intakhin are of the same type and produced similar wares (fig. 36).⁸ Another less researched kiln site is at Lampang. One site of two groups of kilns in the north near Phan is atypical in that the kilns



Fig. 36. Inground kilns excavated at Intakhin, Thailand.

are a surface type built of brick. The kiln form, construction, firing technology, and wares are similar to the LASW phase of Sawankhalok, and at present the site can best be explained as a result of transfer from that center.

Far to the east of the other sites within modern Thailand, near Akat Amnuay in Sakon Nakhon province (and close to Laos), are eight or more sites containing perhaps hundreds of apparently transitional-type crossdraft kilns dotted along the Songkhram River, which is a tributary to the Mekong River (Rakchonok 1993; Walailak 1996; Retka 1999). Reportedly the kilns were partly dug

into the riverbank and clay domes added. The kilns are smallish with a length of about five meters and width of 2.5 meters and a round or perhaps slightly squarish chimney of about

⁷ The heat-hardened “wall” of an inground kiln at Wang Nua was dug out of the ground and the tortoiseshell-shaped pieces were reconstructed on the ground surface at the Chiang Mai National Museum, much to the confusion of all who see it. The exhibited kiln also has a hole in the side, which I believe was deliberately left so that visitors could see inside, but which has been incorrectly described as a loading aperture. No such hole originally existed or has been found at all in the Inland Zone.

⁸ Like those of San Kamphaeng, the kilns at Intakhin have been incorrectly interpreted as clay slab built and belonging to the “aboveground” group, when they are in fact inground kilns (Sayan and Suphamas 1997, 28).

seventy centimeters diameter. The firebox is only a little offset from the sloping firing chamber, a feature common to jar kilns. The jars have a distinctive runny brownish glaze of a type found among the debris and recovered from secondary cremation burials in the area. The use of jars for cremation burials suggests a possible cultural relationship with the MON phase of Sawankhalok, where the same burials are found. Geographically the Songkhram kilns appear to represent an outlier site of technologically related centers in Laos and Lan Na. Design elements such as the “recumbent S” applied decoration found at Songkhram River sites is also common to Si Sattanak, Ban Xang Hai, Lan Na, and (less so) Sawankhalok.

In the central north of Thailand, Sukhothai, the first Thai capital, and its sister city of Sawankhalok dominate the historical scene due to their extensive participation in the ceramic export trade of the fourteenth through sixteenth centuries. There is debate about which of the two centers was established first, although the MON phase at Sawankhalok appears to predate any production at the much smaller site at Sukhothai. The range of wares from the two sites can be easily distinguished by clay fabric characteristics, and Sukhothai ware was limited to clear glaze over slip and a smaller range of underglaze painted decoration. The brick-built crossdraft kilns of Sukhothai are similar to those at Sawankhalok, but smaller and with a unique lancet-shaped cross section, which made the kilns taller. Exactly how the wares were set to fill the high firing chamber is not yet understood. The industrial area of Sukhothai only extends over a few hundred square meters and does not display the archaeological depth evident of Sawankhalok. However, there is one important question at Sukhothai yet to be answered. Fewer than twenty crossdraft kilns have been found, and they are concentrated in two areas that include updraft kilns as well. Updraft kilns are also found in several other areas. In some cases the updraft kilns are associated with unglazed roof tiles, but otherwise the main debris is of typical Sukhothai glazed wares. The question of whether some updraft kilns at Sukhothai were used to fire glazed ware remains to be fully addressed (Anon. 2008).

The matter of historic updraft kilns in Mainland Southeast Asia has yet to be satisfactorily considered. As noted above, few updraft kilns have been reported in the Coastal Zone, nor are they common elsewhere.⁹ None are known in Laos, and there is only the one certain site in Burma (Sayohpho). To date, most kilns of this type have been discovered in Thailand mixed with crossdraft kilns. Updraft kilns are also found at Sawankhalok, where they were used to produce unglazed roof tiles and pots, but determining whether they were used for any other purpose, especially in the case of updraft kilns found in close association with crossdraft kilns, requires further research. Updraft kilns were used at Lamphun, the capital of the Mon Hariphunchai kingdom located near Chiang Mai. The authors of the field report suggested a ninth- to thirteenth-century date for the site (Natthapatra and Bhujjong 1989). No technical details of the kilns are available, but one structure was described as “twin kilns” because there were two adjacent fireholes, although in that case it is more likely there was one kiln with two fireholes. One of the forty or so updraft kilns at Sukhothai has a double firebox. Debris shows it was used to make roof tiles. Like several found at Sawankhalok, it has a square ground plan rather than the usual circular shape. Historic updraft kilns have also been reported in the south near Nakon Si Thammarat, but no definitive drawings or descriptions are available.

⁹ During extensive search in the Inland Zone, I was sometimes guided to kilns used in earlier times to make charcoal, but despite the superficial resemblance to updraft kilns, the structures are fundamentally unrelated.

At Ban Tao Hai, Phitsanulok province, five crossdraft kilns were identified and one excavated in 1984 (Hein and Prachote 1985). Located on the left bank of the Nan River, the kilns were built of brick using a distinctive pattern created by laying the bricks along the line of a V such that during construction from both ends no frame support was required. (Sawankhalok and Sukhothai used a similar technique but in a slightly different pattern.) The main benefit was not so much that it lessened expenses by not requiring a

framework, but that the method allowed the potters to build the kiln walls while standing inside the structure, a particular advantage as surface kilns became larger. The main products were storage jars and other domestic wares including lidded jarlets, globular jars, mixing bowls (mortars), small bowls, and flared-mouth jars with applied decoration that was almost identical to the same type at Sawankhalok. Some wares had a thick black or dark brown glaze, but most were unglazed. The finds included one glazed ritual figurine, identical to those made at Sawankhalok, except for many stamped impressions of a design that is otherwise only found as a potter's mark. These geometric and pictorial potters' marks were of a kind not found on ceramics elsewhere in Thailand, but were similar to stamped marks found on bricks used in the construction of a local Buddhist monastery. Some of the designs are similar to stamp marks on silver "bullet money" (*pot duang*) excavated at Sawankhalok (Hein 1987). The Ban Tao Hai kiln site appears to be a late extension of Sawankhalok.

Another noteworthy site in the central northern area is at Ban Rachan near Singburi (sometimes referred to as the Maenam Noi kiln site), which contains the largest historic kilns in Thailand (Charuk 1990). They are brick-built and measure up to fifteen meters long and five meters wide, resulting in a huge dome that has no additional internal support (fig. 37). The chimney diameter is more than two meters and the firewall height more than one meter. The few kilns were built on a huge artificial mound. The mound itself, largely composed of wasters and kiln debris, has not been excavated and what underlies the surface kilns is unknown. Rather coarsely potted medium-size jars and mixing bowls were the main products, and many have been found in export contexts. In form, the Ban Rachan kilns imitate the last kilns of Sawankhalok but are larger in size.

The foregoing kiln sites belong somewhere within the twelfth- to eighteenth-century time zone, but more recent centers represent a continuation of ceramic production. A kiln site called Huay Mae Tam, near Khun Yuam in Mae Hong Song province, is close to the border between Burma and Thailand (Sayan 1999). Several inground kilns were dug into steep riverbanks and produced green-glazed stoneware jars, bowls, and small dishes with stamped and applied decoration of Burmese style.

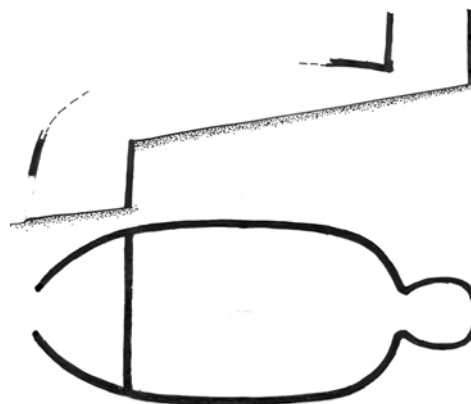


Fig. 37. Large (five by fifteen meters) brick-built surface kiln in Bang Rachan district (Maenam Noi), Singburi province, Thailand.

At Chiang Mai in Lan Na, several large surface crossdraft kilns very similar to those of Sawankhalok operated from early in the twentieth century until the 1970s making green-glazed domestic wares, medium-size jars, flower pots, etc. (fig. 38). The (ethnically Tai) potters of both sites are said to have come from the Shan state of Burma, and at least in the case of the Chiang Mai kilns, their move to Thailand may represent a return of Thai technology supposedly taken to Burma by captive potters after the 1569 invasion (Hall 1970:268).



Fig. 38. The "Shan" kiln at Chiang Mai, Thailand, that operated for the first three quarters of the twentieth century. It was probably a descendant kiln of the Sawankhalok type.

The Means of Transfer

It is evident that production technology was not independently invented by each Southeast Asian site, but that the knowledge originally disseminated from a Chinese source. Irrespective of what might have caused the transfer from one place to another, some fundamental principles dictate how it occurred.

Traditionally, the craft skills of pottery were learned by apprenticeship, the gradual adoption of knowledge from someone already familiar with the tools and processes involved, some of which are easily understood and readily learned while others are more subtle and complex. In particular, the understanding of the spatial interior of a kiln and how it works grew out of long experience, including practice in building kilns. The high-temperature kiln is a sophisticated instrument, and a precisely integrated relationship of the shapes of its firebox, firing chamber, and chimney is vital in obtaining satisfactory temperature level and control. While many forms can satisfy the need, that relationship remains constant. There may be very little difference between a kiln that works well and one that does not. Consequently, potters making new kilns exactly duplicated the best-functioning existing model. The status quo was maintained and change was slow and gradual; every site that has been carefully studied displays that condition.

There is no evidence to suggest that such knowledge was represented by model, diagram, or written description. Rather, when a new kiln was built, the required expert knowledge was provided by the participation of an appropriately skilled person; that is, such a person had to be present for the efficient and successful establishment of a new production site. In brief, when kiln technology moved from one place to another, it was carried in the head of an artisan. Therefore dissemination of kilns is a consequence of the movement of potters. Furthermore, those kilns and the processes used in their operation could only be those that the potters knew. Any kiln they built, processes they used, or forms they made would be duplications of the technologies and ideas current at the progenitor site.

This hypothesis pertains to technology transfer from a functioning production center to a new location where no ceramic industry existed, and is an explanation, irrespective of ethnicity, of how ceramic production spread from China to Southeast Asia. Due to

environmental conditions and market demand, along with a subtle, perhaps unconscious, inclination toward innovation, change did occur but there was a tendency for original characteristics and attributes to remain evident. Therefore, between the parent sites in China and the numerous descendant kiln sites of Mainland Southeast Asia, there potentially exists the material evidence of an unbroken chain linking generations of potters of various cultures and nationalities who learned their trade and passed it on. It is implicit in this paper that the author believes that the kiln, as the largest, most critical, and most enduring tool of the potter, is the prime artifact of evidence in tracing influence.

The longevity of kiln types results from a number of coupled factors: the participation of experienced and skilled potters, who were essential to the transfer of ceramic technology; infrequent change in the form of kilns due to the compelling need to duplicate successful models faithfully; and the long period of time that individual kilns remained operational. In comparison, change in the form and decoration of wares was much more readily affected and could result simply from an expressed preference of a trader offering an example for copy. This is obvious at Sukhothai, where pieces of iron-painted Vietnamese wares found among wasters at the kilns were the models for local production. Similarly, at Sawankhalok the designs on MASW stoneware that appear to originate in the Coastal Zone were incorporated into later wares, yet there is no hint of Coastal Zone kiln design. There is no example published in detail that demonstrates that the introduction of ideas for new forms and decorations to an existing kiln site was accompanied by changes to the means of production.

A Bi-Zonal Concept

A hypothesis based on current knowledge that may explain the disparity of the geographical division of high-temperature kiln technology throughout Mainland Southeast Asia is that at least two founding influences from two different locations in China were introduced separately at two different times to the coastal and inland areas of Mainland Southeast Asia. A strong indication of a separate influence between the Coastal and Inland zones is that constructed surface kilns were introduced into Vietnam long before inground kilns appeared anywhere in the interior. The sequential separation and conceptual difference between the two types of kilns is so great as to preclude any notion that founding influence could have occurred between the zones.

In the Coastal Zone, the historic kilns of coastal North and Central Vietnam and Cambodia (including Angkorian kilns in Northeast Thailand) appear to belong broadly to a single tradition. All are surface types with a more or less rectangular plan and at least some of the following attributes in common: multiple fireholes, multiple fireboxes, “fire-dividing” or dome-supporting pillars, vents in lieu of chimneys, clay construction, and loading doors. No developmental sequence has yet been proposed, but the kilns do become larger over time. The introduction of the Han dynasty kilns at Tam Tho may be assumed as the establishment of a satellite industry in a new colonial domain of China, with the parent source from one of the many kiln sites along the southeastern littoral. It is that particular surface crossdraft kiln technology that underwent change while disseminating southwards and later westwards into Cambodia and perhaps what is now southern Laos, but no further. Too little is presently

known of Coastal Zone kiln sites to assess the probability of local development against the possibility of further events of transfer from China to account for differences between kiln sites. In either case, the tubular shape of kilns introduced into the Coastal Zone is congruous with an early stage in form transition toward the *long* (“dragon” or hill) kilns of neighboring China. The potters who built the kilns of Tam Tho were almost certainly Chinese, but in all likelihood Vietnamese became involved in the industry and acquired the knowledge and skills that allowed them later to establish replicated sites in new locations.

Whether Chinese potters were involved at other ceramic sites within modern Vietnam has yet to be determined, but would be certain if there were additional influence from China and much less likely if ceramic production had become predominantly Vietnamese. By the same reasoning—that skilled potters are the key to the establishment of a new industry—several possibilities arise. Either the introduction of the kiln into the Angkor kingdom came as a result of potters going from Vietnam to the Mount Kulen area to begin an industry, or somehow Cambodians acquired the skills, or influence came directly from China. It seems unlikely that China would have permitted a series of ceramic technology transfers potentially to the detriment of its own industry. The absence of such influence elsewhere in Southeast Asia and indeed in the whole trade-related world may indicate reluctance for such action.

With respect to the Inland Zone, the case for a single-source, single-event transfer is stronger due to the singular form of the kiln and the evidence of local development. Kilns began as an inground type and all subsequent development of the kiln remained within that conceptual constraint. With only slight distinctions, the kilns of the Inland Zone—whether dug into the ground or constructed on it—are of a single form, an expandable but not extendable ovoid. That original form remained constant, and essentially all change was simply toward a larger size and more efficient version of that paradigm.

Compared to the relative certainty of the origins of crossdraft kiln technology in the Coastal Zone, the source of influence regarding the inground crossdraft kiln in the Inland Zone is much more conjectural. It is possible that the technology came from a kiln site somewhere in Yunnan province in southwestern China, but if the theory is correct that Tai peoples migrated westwards from the mountain region of northern Vietnam into what is now Laos, Thailand, and northeast Burma, the source could also be Guangxi province. Unlike the circumstance of Vietnam, there is no colonialist explanation for the introduction of kilns into the Inland Zone, and the influence probably occurred as an element of informal migration. Concerning further dissemination within the Inland Zone, it seems reasonable to assume that the potters were part of the gradual expansion of immigrant people toward the west and south. However, early ceramic production in that area is associated with Mon people, who at times occupied lower Burma as far north as Prome and much of Thailand, so it is (perhaps remotely) possible that the knowledge of the crossdraft kiln first passed into the hands of the Mon.¹⁰ There is a fascinating similarity between the form and decoration of the MON glazed stoneware of northern Thailand and those of certain early Chinese wares (Mino 1975), rather than those of tenth-century Chinese wares. If, as current evidence suggests, the introduction of the crossdraft kiln occurred in the tenth or eleventh century, the wares made would resemble those of the Five Dynasties (907–960) and Northern Song (960–1127) periods, and correspondingly, so would the kilns. Allowance should be made,

¹⁰ See Guillon 1989 for an opinion on the extent of Mon culture in Southeast Asia.

however, for the possibility that the influence came from provincial kilns retaining older ideas.

The study of kilns is a specialized aspect of archaeology that assumes understanding of historical and theoretical principles (including kiln evolution and usage, fuel combustion, and the physical and chemical characteristics of clay) and, at the least, vicarious experience in the building and operation of kilns. Published interpretations are occasionally erroneous and so tend to obscure the truth. As stated or implied here, kiln types are sometimes misunderstood and incorrectly classified, the kilns and related infrastructure are too often insufficiently excavated and thereby inadequately recorded, and in the case of Southeast Asian kilns, such frequently seen statements as “built of prefired brick” is usually wrong (Hein, Hill, and Ramsay 2004). Such points matter. As an example, for practical and perceptual reasons, kilns consisted or were made of raw clay. Change to prefired materials would represent a significant conceptual shift, and inaccurate data could make tracing sources more difficult.

There is no doubt China was the source of founding influence of the crossdraft kiln in Southeast Asia, and there is no evidence in Southeast Asia of independent invention of that principle. The inference of extensive and direct injection of Chinese technology by Chinese potters proliferates in published statements, but solid evidence is lacking. Rarely are Chinese cultural attributes found in association with kiln sites: no graves, coins, domestic artifacts, gambling tokens, or the like usually found at Chinese habitation sites, and—more directly in relation to ceramics—no Chinese potters’ marks or character inscriptions. There is no reference to Chinese records, normally so precise and detailed, reporting on the movement of potters or ceramic enterprises into Southeast Asia.

Other factors also fail to indicate the contemporary presence of Chinese potters. Under the assumption of transfer explained above, any direct Chinese influence in the twelfth or thirteenth century could only have been of contemporary style and technology. At least in respect of the Inland Zone, however, the first kilns and production methods are among the most primitive—that is, inground kilns and unprocessed secondary clays used to make simple, flat, wide-bottomed bowls of a type not produced at any of the major Chinese centers. At Sawankhalok, the failure for several centuries to exploit abundant white primary clay as a body is inexplicable under the premise of Chinese potters’ presence. There are other issues, such as the near absence of saggars as a setting method in favor of rim-to-rim boxed pairing—a technique that does not fit with contemporary Chinese practice. In essence, the introduction into the Inland Zone of Chinese ceramic technology is more consistent with migration than of Chinese commercial enterprise.

It has been suggested that influence from Guangxi province led to the establishment of ceramic sites in northern Vietnam (Scott 1995), but the Guangxi “dragon” kilns bear no developmental or technical relationship to those of Thanh Hoa. In respect of typology, a better case of origins is made by Ho Chuimei (1995) for “unusual” ninth-century inground “cavity” kilns at Meixian in Guangdong province. Also, her suggestion in the same paper that the late-Sawankhalok crossdraft kiln might have provided the model for the “egg-shaped” *zhen* kiln, which first appeared at Jingdezhen at about the time Sawankhalok was

in decline, better fits currently known facts.¹¹ A convincing line of development in China has not been made, but the *zhen* kiln is a near copy of late-Sawankhalok or Maenam Noi kilns. Visiting traders could well have realized what the Thai potters did not—that there was potential for the large-volume Sawankhalok kiln to contain tall stacks of saggars and produce larger amounts of better-quality wares over a short firing cycle (compared to the *long* kiln). Transfer could have been facilitated either by the employment of a skilled Thai or by the introduction of a Chinese potter to study the kilns.

The common claim that various historic kiln sites in Mainland Southeast Asia were a consequence of the occasional introduction of contemporary ceramic production technology by Chinese potters is not sustained by current archaeological or historical evidence. While influence through trade on ware form and decoration is apparent, there is no certain example of the transfer of production technology other than that inherent in the foundation of the first kilns in both zones. Subsequent development can be explained by local innovation and commercial imperative. The most convincing point against periodic Chinese influence on production is the absence of the much more efficient means and methodology practiced in China.

To summarize archaeological findings at production sites, two particular kiln types exist in Mainland Southeast Asia, each confined to a distinct geographic zone characterized by indigenous and migrant ethnic groupings. Such a condition is more likely to result from a process of incremental and sequential change rather than from a series of technical intrusions occurring at random at different times and places. In this light, the coincidence of the expansion of some sites to participate in the export trade at the time of a hiatus in Chinese foreign maritime commerce may be seen as consistent with local response to commercial opportunity rather than as the transfer of Chinese ceramic production into Southeast Asia.

¹¹ In my dissertation (2001, 242) I presented as my own the notion that the Jingdezhen *zhen* kiln was based on the Sawankhalok surface kiln, as at the time I believed it to be an original idea. However, as Chuimei Ho's publication of the concept clearly predates mine, I acknowledge her right to the claim.

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