

Ceramics-Firing Kilns of the Southern Russian Far East: Technological and Temporal Dynamics

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Abstract: The temporal dynamics of ancient kiln-type ceramics firing structures in the southern Russian Far East bordering China and the Korea peninsula are introduced. The development of ceramics-firing kilns was an important component of technological and cultural history in the region. The oldest evidence of simple kiln-like devices discovered are from the Paleometal period, dating to between 1000 BC and 1000 AD. An example of a vertical updraft firing kiln dates to the Pre-State period around 500 AD, and elaborated kilns have been discovered at sites from the Bohai State period (698–926) and the Jin Empire period (1115–1234). Bohai kilns are of a tunnel-like sloped type, and Jurchen kilns are of a one-chambered “*mantou*” type. The quality of ceramic products indicates that technical capabilities varied, and the examination of specimens fired in certain kilns with scanning electron microscopy and other methods are discussed.

Keywords: Kiln remains, updraft kiln, cross-draft kiln, temperature and atmosphere regimes, pottery, roof tiles, SEM, archeometric analysis

11.1. Introduction

This chapter introduces the development of kiln firing technology in the pottery-making of prehistoric and ancient populations of the southern Russian Far East. The research area is the Primor’e Region, lying to the south of the Lower Amur River and bordering northeast China to the west and the Korean peninsula to the south (Fig. 11.1). According to archeological data the earliest evidence of ceramics-making technology in this territory are dated to around 10,000–7000 BC, which is close to the time of the appearance of pottery in northern China, 10,000–7000 BC, and the southern part of Korean peninsula, ca. 8000 BC (Cho & Ko 2009; Jordan & Zvelebil 2009; Zhushchikhovskaya 2009). During the Neolithic, around 6000–1200 BC, ceramic wares became common, judging by the numerous pottery assemblages coming from archeological sites excavated at various localities in the Primor’e Region. The technology of pottery production at that time was relatively simple and undeveloped. In particular, there is no evidence of pottery firing in kiln-like devices. According to the results of archeological ceramics examination and experimental studies, bonfire (open firing) technology with average firing temperatures of 600–50°C seems to have been practiced widely during the Neolithic (Zhushchikhovskaya 2005: 76–77).

Obvious progressive changes in the physical properties and functional qualities of ceramics took place during the Paleometal period, corresponding primarily to the first millennium BC. These changes concern technological skills as well as morphological and decorative standards.

Among the most important changes were increased firing temperatures as a result of improved thermal processing techniques and technologies. The earliest archeological evidence of kiln-like structures in the southern Russian Far East is given in the fragmented remains of sites belonging to the Paleometal period. The remains of more complex, developed and better-preserved ceramics-firing kiln constructions were excavated at sites of the Pre-State period, fourth to seventh centuries AD, and especially at the sites belonging to the Ancient States period, eighth to thirteenth centuries AD. The research area at that time was initially part of the Bohai Kingdom, 698–926, and later part of Jurchen states – the Jin Empire and Dong Xia states – dating generally to 1115–1233 (Zhushchikhovskaya & Nikitin 2014, 2017).

For the Russian Far East as a whole, the Primor’e Region is the only one where the temporal sequence of excavated remains of early firing structures is known. These archeological relics give us important information about the temporal and cultural dynamics of the kiln firing technology applied to ceramics production in prehistoric and historic times. Various kinds of archeological evidence concerning kiln firing technology can be distinguished. The main evidence is, obviously, the excavated remains of firing devices, which are quite important for judgments about the type of kiln construction and its technical capabilities. The fired ceramics discovered inside the excavated structure or in close proximity are of great value for detecting a kiln’s working conditions such as temperature and atmospheric regimes, and the estimation of the quality of the finished product. The bulk of ceramic artifacts discovered at

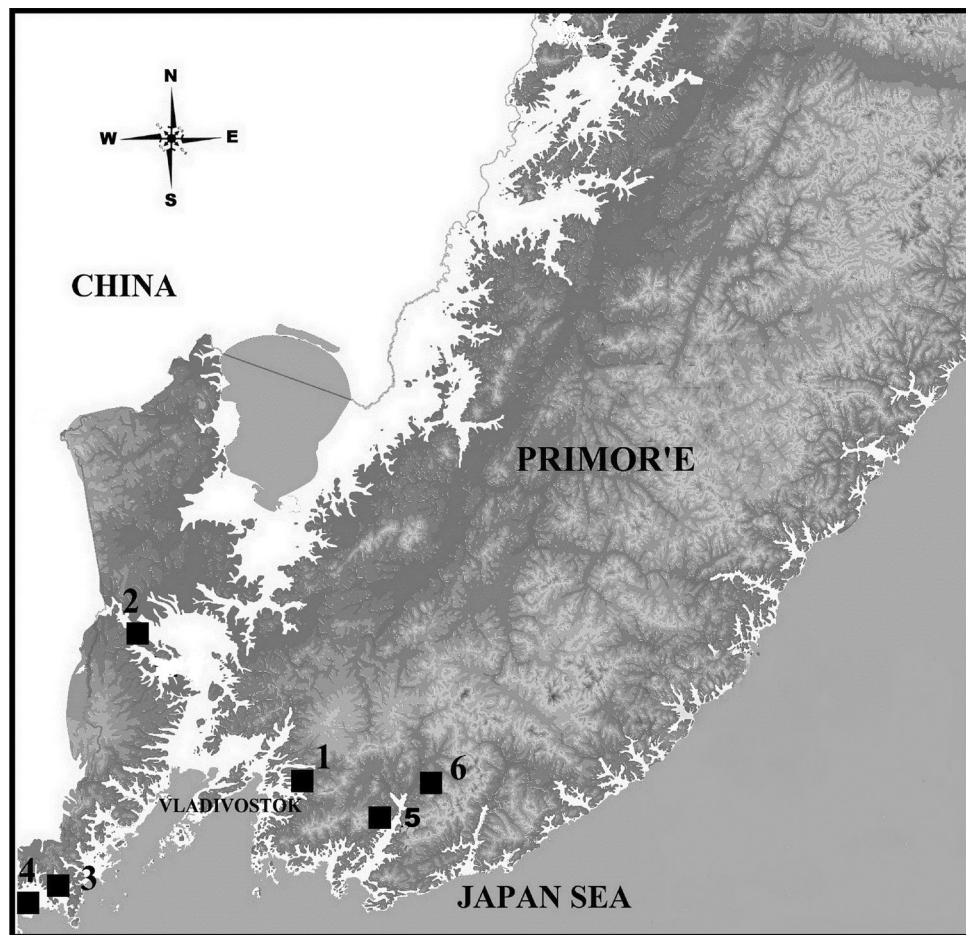


Figure 11.1. Research area and locations of referenced sites. 1: Malaya Podushechka; 2: Chernyatino-2; 3: Troitsa; 4: Kraskino walled settlement; 5: Sergeevka; 6: Lazovskoe walled settlement.

archeological sites is used as an additional source of information on firing technology. In current research the set of methods, including testing by refiring, color analysis, water absorption testing, surface hardness testing, thin-section analysis and SEM-EDS analysis, is applied to determine the ceramics' features and properties brought about by the conditions of firing. These methods are commonly used in archeological ceramics studies (Shepard 1985 [1956]; Bjork 1995; Daszkiewicz & Schneider 2001, Daszkiewicz 2014; Day et al. 2006; Quinn 2009; Maniatis 2009; Gasparic et al. 2014).

Archeological data from the Primor'e Region on kilns for firing ceramics are considered a part not only of technical and technological history but also of cultural history. By tracing the origin and spatial spread of the types of kiln construction it is possible to identify cultural interactions and influences. The history of the research area has been closely connected with the history of other territories of East Asia and, in particular, China, which from the earliest times was the "native land" of many technological innovations. This concerns in great measure ceramics technology, especially firing devices such as long ("dragon")-type kilns and *mantou* ("steamed bun")-type kiln construction (Kerr & Wood 2004; Hein 2008; Gerritsen 2012).

This chapter considers archeological materials on ceramics kilns and the dynamics of firing technology in the southern Russian Far East in chronological and historical order, distinguishing the Paleometal period, Pre-State period and Ancient States period.

11.2. Paleometal period: the oldest firing devices

The Paleometal period is represented by a series of archeological sites within the temporal framework of the border of the second to first millennium BC and the early first millennium AD. That was a time when the first metals – bronze and iron – appeared in the southern Russian Far East almost simultaneously, with very short temporal separation. Metal artifacts are few at sites of the Paleometal period, and no sure traces of local bronze and iron metallurgy have been detected to date. Currently, in archeological studies of the research area the term "Paleometal" has been adopted to be more flexible and correct than the classic definitions "Bronze Age" and "Iron Age" (Zhushchikhovskaya 2018; Popov et al., 2020). The origin of the imported early Russian Far East bronzes – ornaments and knives – is strongly debated (Kon'kova 1989, 1996). The first iron items – axes, knives, arrowheads – are also viewed as imported. The territories of northeast China and the Korean peninsula may be considered as probable

regions from which the first bronzes and irons could have come to the Primor'e Region in the first millennium BC. The sites containing the most important evidence of the first bronzes are concentrated in the western and northwestern Primor'e Region and are dated around the tenth to seventh centuries BC. Prehistoric sites containing iron artifacts are grouped in two archeological cultures – the Yankovskaya culture, ninth/eighth to third/second centuries BC, and the Krounovskaya culture, fourth century BC to third/fourth centuries AD. The Yankovskaya culture area occupied mainly the seacoast of southern and partially southeastern Primor'e; sites of the Krounovskaya culture are situated mainly in the continental areas of the southern part of the Primor'e Region. Although evidence of local iron artifact production is not yet known, traces of “cold” and “hot” metalworking have been detected at some sites of the Yankovskaya and Krounovskaya cultures (Popov et al. 2020).

The Paleometal period definitely marks a new level in the historical development of the southern Russian Far East. Archeological records of the Paleometal period indicate obvious changes in cultural traditions, economy and mode of life in comparison with the Neolithic. In particular, numerous pottery assemblages discovered in Paleometal sites differ significantly in their technological, morphological and decorative features from Neolithic pottery. In turn, the sites of the Yankovskaya and Krounovskaya cultures provide evidence of the most developed technological standards of pottery production. It must be emphasized that the earliest remains of kiln-like structures for ceramics were discovered in sites of these cultures (Zhushchikhovskaya 2005: 76–79; Popov et al. 2020).

11.2.1. Yankovskaya culture

The remains of firing structures were discovered at a single site of this culture – the long-term settlement of Malaya Podushechka (translated as “Small Pillow”), located on a small pillow-like hill in a river valley about 20 km from the seacoast in the southern Primor'e Region (Fig. 11.1). This is a two-component archeological site. The lower component is represented by a settlement of the Yankovskaya archeological culture that was almost completely excavated in the mid-1960s. According to the settlement, about 1000 m² contained the remains of seven pit-dwellings and 15 ground burials scattered around. An assemblage of iron artifacts, including several axes, knives and arrowheads, was found during excavations of the Yankovskaya cultural layers. The site is dated to 480±50 BC (Andreeva et al. 1986: 39–50, 190).

Three localities of fragmentary remains of kiln-like firing structures were discovered within the settlement area. The remains looked like amorphous oval-like heaps of burned pieces of clay with inclusions of traces of coarse straw. The thickness of the heaps of the burned clay pieces was up to 0.3–0.4 m. The heaps were situated on smooth ground and were arranged in a row at a distance

of 3.0–4.0 m from one another. The horizontal plan of two heaps was about 3.0 m by 2.0 m, with one about 5.0 m by 4.0 m. At this largest location small pits were discovered around the burned clay heap – probably traces of a wooden canopy-like structure. At one locality the smooth ground under the heap of burned clay pieces was covered by a thin layer of burnt clay. Inside the heaps, assemblages of well-preserved fired ceramic vessels of mostly medium sizes were found. The number of vessels varied from 5 to 10 at different heaps. The bright color of the vessels' surfaces indicates an oxidizing firing regime.

In general, the firing devices discovered at the Malaya Podushechka settlement can supposedly be reconstructed as simple structures built of daub, i.e. clay mixed with chopped straw. No clear evidence of fuel and firing chambers, or separate areas, was detected. Kilns of this type usually have two holes – one for loading fuel and another for the draft. It seems likely that the presumed firing structures were similar to devices still employed in traditional pottery-making in some regions of the world (Bareš et al. 1982: 191–208). The remains of simple kiln-like updraft firing structures built of clay or daub have been excavated in several places in the world. These are cases of kilns unearthed at Neolithic and Bronze Age settlements in Czech territory (Thér 2004; Thér & Gregor 2011), at Eneolithic settlements of Central Asia, about the middle of the fourth to the middle of the third millennium BC (Khlopin 1964: 120–23), and at the Eneolithic Krašnja site in Slovenia, dated to 4750±35 BP (Gasparic et al. 2014).

One cannot judge the temperature regime of the kilns discovered at the Malaya Podushechka site accurately, because the ceramics found inside have been studied by their morphology and external technological features but not with scientific analyses. However, the examination of pottery samples from various sites of the Yankovskaya culture provides some knowledge about the adopted firing technology. Previously, based on the results of refiring testing and thin-section analysis of selected samples from several sites, it was supposed that the average temperatures of firing pottery in the Yankovskaya culture were 700–750°C (Zhushchikhovskaya 2005: 76–78). Such temperatures could be achieved in simple kilns or even in bonfires. Recent investigations are precisising this conclusion.

The average water absorption (WA) index for oxidizing-fired ceramics from several Yankovskaya culture sites (settlements) varies from 12.4 percent to 18.6 percent. The measurement procedure is well established and described e.g. by Shepard (1985 [1956]: 127) and Rice (1987: 351–53), and explanation of the data gained from the measurements is based on the scientific evaluation of the ceramics WA indexes. WA values of 5.0 to 7.0 percent and less are evaluated as very low ones, corresponding to a true dense ceramic body of high quality. The 5.0 to 15.0 percent values are estimated as moderate ones, corresponding to a ceramic body of satisfactory

quality. Values of 15.0 percent and more are high ones, corresponding to a porous, fragile and weak ceramic body (Avgustinik 1975: 221–22; Shepard 1985 [1956]: 127–30). So, it may be concluded that different average WA indexes of the pottery from various Yankovskaya culture sites indicate different quality levels of the finished products.

SEM-EDS examination of pottery samples from different sites shows various kinds of ceramic body microstructure, depending on the degree of clay sintering (vitrification) and correlating in general with the measuring of data on the WA index (Zhushchikhovskaya 2017). In the ceramics assemblages with moderate average WA indexes (12.4–13.5 percent) there are certain samples

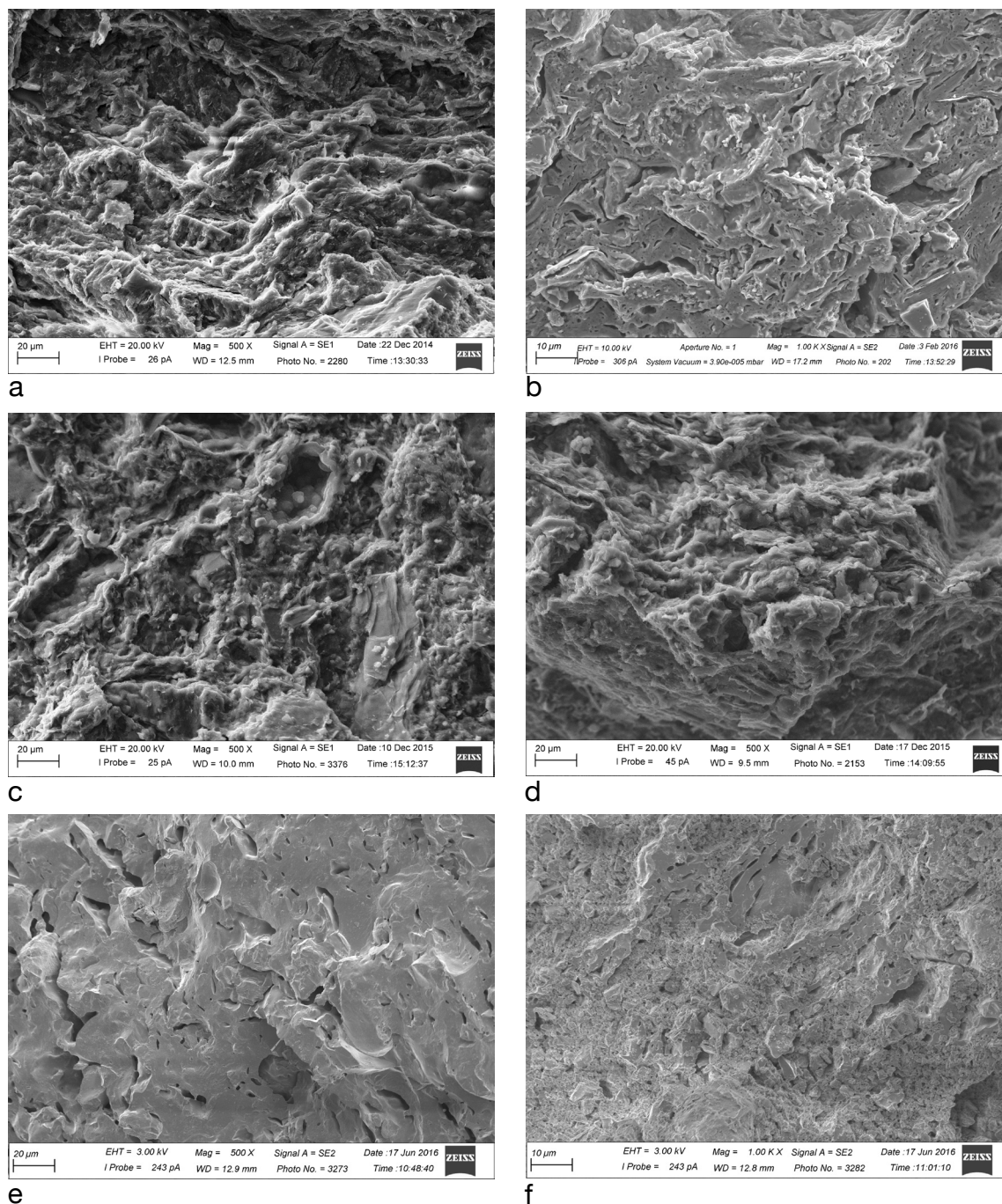


Figure 11.2. Electronic micrographs of ceramics body samples with different grades of vitrification. a: Paleometal period, Yankovskaya culture, Solnechnyi Bereg: initial vitrification (Zhushchikhovskaya 2017). **b:** Paleometal period, Krounovskaya culture, kiln area in Chernyatino-2: extensive vitrification (Zhushchikhovskaya & Nikitin 2019). **c:** Paleometal period, Krounovskaya culture, kiln area in Chernyatino-2: initial vitrification (see b). **d:** Pre-State period, Troitsa kilns site: initial vitrification (unpublished). **e:** Ancient States period, Kraskino walled settlement: extensive vitrification (Zhushchikhovskaya 2017). **f:** Ancient States period, Kraskino walled settlement: initial vitrification (see e). **g:** Baekje period, Korea. Neungsanri saji. Microstructure with the evidence of almost total vitrification (see e). **h:** Ancient States period, Sergeevka kilns site: extensive vitrification (see e). **i:** Ancient States period, Sergeevka kilns site, microstructure with evidence of almost total vitrification. **j:** Ancient States period, Sergeevka kilns site, microstructure with evidence of extensive vitrification. **k:** Ancient States period, Sergeevka kilns site, microstructure with evidence of initial vitrification.

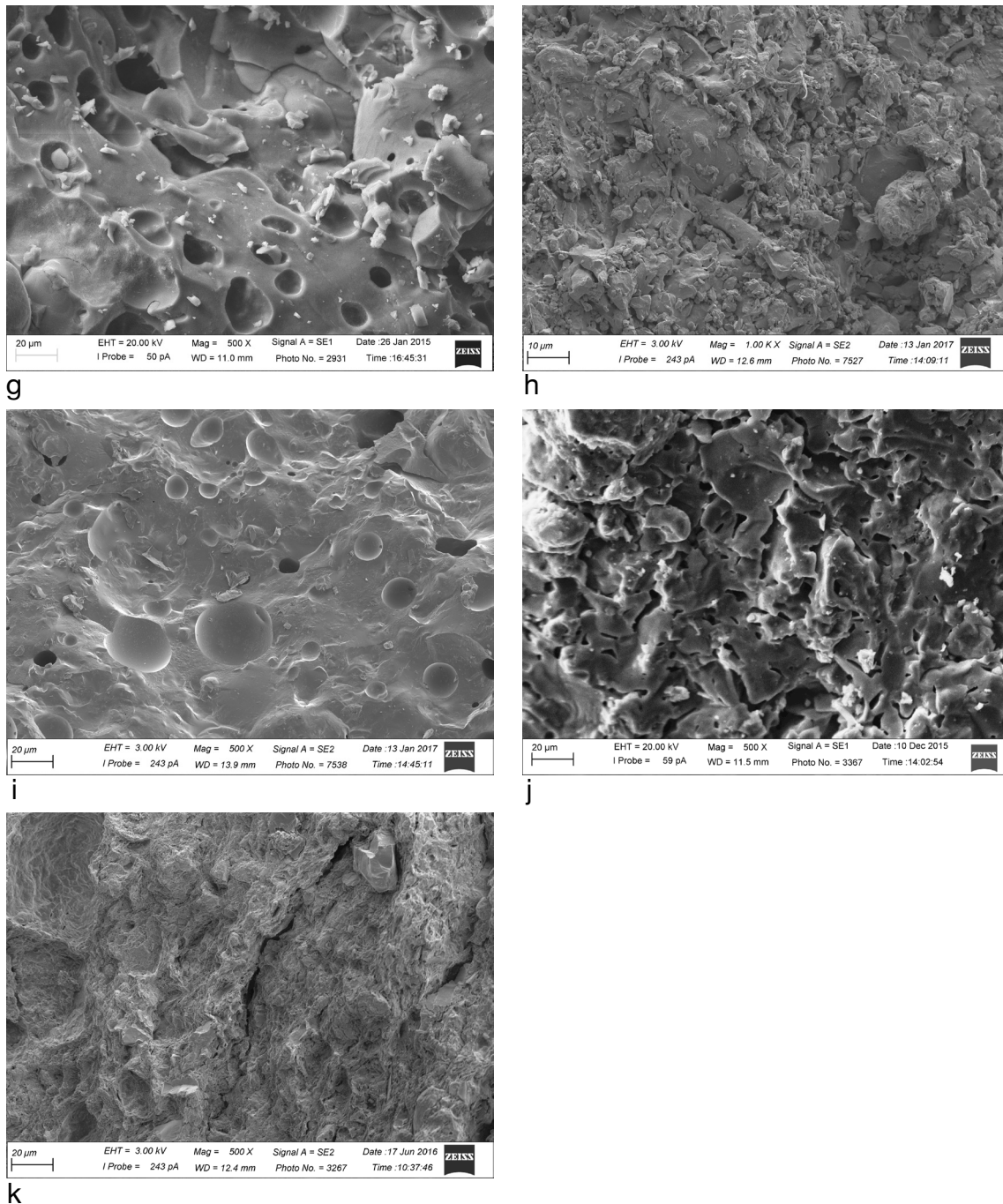


Figure 11.2. (Continued).

with relatively low WA values (8.4–10.5 percent) and traces of initial vitrification of the clay matrix (Fig. 11.2a). These observations indicate a probable firing temperature of 800°C and above for non-calcareous clays (Tite & Maniatis 1975; Maniatis 2009). For comparison, samples with WA values ≥ 12.0 percent show no evidence of clay matrix vitrification. According to research data a temperature up to 800°C may be achieved in the simplest prehistoric updraft kilns. This temperature is supposed for the Eneolithic kilns excavated at the Krašnja site in Slovenia (Gasparic et al. 2014).

Supposedly, the different qualities of ceramic bodies may be explained by some differences in firing technology.

Temperatures of 800°C and above correspond to kiln firing rather than a bonfire. The discovery of simple kiln-like remains at the Malaya Podushechka settlement and the data of ceramics examination indicate the usage of kiln firing technology. However, it seems likely that this technology was practiced sporadically, not being the uniform standard of pottery-making.

11.2.2. Krounovskaya culture

The only evidence of a pottery-firing kiln structure was discovered at the multi-layered site (settlement) of Chernyatino-2, located on the bank of the Orlovka River in the western Primor'e Region (Fig. 11.1)

(following a description of the findings according to Zhushchikhovskaya & Nikitin 2019). The remains belong to a layer of the Krounovskaya culture substantially destroyed by the activity of later settlers, though preserved in some parts of the site. Preliminary dating of this cultural layer is about third to fourth centuries AD. It was definitely noted that a firing kiln was located inside the Krounovskaya culture settlement area, in the vicinity of the pit-houses. It is possible to determine the main structural features of the firing kiln.

The kiln's floor, lying 0.20 m deep below the surface, was oval-shaped in contour, 2.30 m in length and of 1.90 m maximal width. The floor had traces of burning and was inclined at 10–15 degrees from the southeast to northwest, with a step-like separation between the lower fuel section (firebox) of about 0.50 m² and the upper firing section (fire chamber) of about 2.48 m². Above the floor and on top of a thick accumulation of burned clay-straw mixture were heaped the remains of the destroyed above-ground part of the kiln. On some burned pieces impressions of a wooden framework were detected. It may be concluded that the firing structure was close to a type of tunnel-like sloping kiln with a dome-like upper part built of a clay-straw mixture on the wooden frame.

Few pottery fragments were uncovered inside the kiln, but many fragments were found in close proximity. Some fragments have visible traces of firing damage such as deformation, cracking and swelling. A few samples had a very fragile, crumbling structure indicating a low firing temperature that was not high enough to allow sintering of the clay. Examination of the pottery samples from the cultural layer where the kiln's remains were unearthed achieved the following results. The ceramics water absorption index rates were from 7.4 to 13.1 percent, with an average value of 10.7 percent. SEM has shown that some samples, in particular the ones uncovered inside and near the kiln remains, have a microstructure with evidence of initial and extensive vitrification (Fig. 11.2b, c). Taking into account that, according to SEM-EDS analysis, the ceramics were made of non-calcareous clays, the SEM data hint at firing temperatures in the interval 800–900°C (Tite & Maniatis 1975; Maniatis 2009). Judging by the pottery surfaces and fracture colors, the ceramics-firing was conducted in most cases under an oxidizing atmospheric regime. However, at the Chernyatino-2 site and other sites of the Krounovskaya culture, series of dark gray or black pottery are present. The refiring of these ceramics samples at a temperature of 500–550°C causes the color to change from black to yellowish, reddish or brown. This definitely indicates a “blackening” firing in a smudging, carbon-saturated atmosphere (Shepard 1985 [1956]: 88–90, 220). The accumulation of “hard” carbon micro-particles causes not only the appearance of a black or dark gray color but also decreasing porosity and water absorption. Within the above-noted range of WA indexes of Chernyatino-2 ceramics the lowest rates are detected for black pottery samples.

The main structural features of the excavated kiln are the elongated contour, slightly inclined floor and step-like separation between the fuel and firing sections. This was a simple structure not of large capacity though the achieved temperatures were enough for producing ceramics of a satisfactory quality. The closest spatial and territorial analogies for these kiln structures are connected with archeological sites of the Korean peninsula of the third to early fourth centuries AD. The earliest evidence of tunnel-like sloping kilns have been recognized at the sites of Sansuri, Daegokri and some others. These tunnel-like sloping kilns were larger and more developed than the kiln at the Chernyatino-2 site. The supposed firing temperature achieved in the Korean kilns is around 1000°C (Barnes 2001: 107–14; Kim 2003). Researchers suggest that the earliest Korean tunnel-like kilns are descendants in their construction type of long, or dragon kilns (Barnes 2001), first invented in China in the first millennium BC (Hein 2008).

In general, the Paleometal period was a time of progressive change in pottery-firing technology in comparison with the Neolithic. Certainly, kiln firing began to be adopted in the research area during the Paleometal period, resulting in firing temperatures increasing and ceramics quality improving. Archeological records indicate a certain synchronization between the appearance of the first metals and metalworking knowledge in the southern Russian Far East in the first millennium BC on the one hand, and an improvement in firing technology in pottery-making craft on the other. The thermal processing of raw material is the technological essence and main condition for the production of both ceramics and metals. The problem of connecting the thermal processes and technical equipment of pottery-making with those of metallurgy and metalworking is a complex study. The data from other world regions allow the supposition that the invention and development of metallurgy and metalworking were the “catalyst” for innovations and achievements in ceramics-firing technology (Kushnareva 1970; Shangraw 1977; Saiko & Terekhova 1981). In the southern Russian Far East there is no definite evidence of the development of local metallurgy or metalworking in first millennium BC (Popov et al. 2020). In spite of this, it could not be excluded that even restricted knowledge about thermal metal processing influenced – directly or indirectly – the technical and technological potential of pottery-making.

11.3. Ceramics kilns of the Pre-State period

This stage of the past history of the southern Russian Far East, dated from the fourth to the seventh century AD, is marked by complex cultural and demographic processes, in particular the coming of new population groups. These processes are described by Dyakova (2014) as follows: The Mokhe (this name is known based on old Chinese historical chronicles) tribes spread widely over northeast China, the Primor'e Region and the Amur River valley down to the coast of the Sea of Japan. Settlements and cemeteries attributed to the Mokhe cultural community are

numerous in the research area, especially in the central, western and southern parts of the Primor'e Region. Artifact assemblages from the sites indicate developed iron and bronze metalworking, elaborated military skills, jewelry craft and other productions and crafts. Horse- and cattle-breeding and agriculture were the main branches of the economy. The Mokhe tribes were an important ethnic component in the formation of the first state in Northeast Asia – the Bohai Kingdom (698–926). The cultural connections and contacts of the Mokhe tribes were very active and widespread, including in northern China and Central Asia.

Ceramic wares were common items in every Mokhe settlement of the Primor'e Region. Several local variants of pottery-making traditions differing in morphological and decorative standards can be distinguished, as well as technological standards (Piskareva 2005). Pottery assemblages from southwestern Primor'e sites show evidence of more accurate shaping, probably with the use of turn-table equipment, and higher-temperature firing in comparison with pottery from some other areas. A single kiln site was discovered on the margin of the southwestern seacoast, in Troitsa Bay (Fig. 11.1). The site, named Troitsa, was mostly destroyed. However, in the preserved part the remains of two kiln-like structures were detected and excavated in the early 1980s (Andreeva & Zhushchikhovskaya 1986; Zhushchikhovskaya & Nikitin 2014). According to the data from fieldwork, both structures can be reconstructed as two-leveled and of roundish horizontal plan. The furnace chamber (firebox) was embedded into the earth to a depth of about 0.80 m and had a fuel-loading hole at the side. The bottom diameter of the furnace chamber (firebox) of kiln N2 was about 1.50 m, and that of kiln N1 was 1.25 m. The bottoms and walls were formed of granitic slabs that had been burned intensely judging from the melting of quartz grains. The upper level of the kiln structure was the firing chamber, with a dome constructed of a clay-straw mixture, probably on a wooden frame. Multiple burnt pieces of the destroyed domes were scattered around the kiln remains. Some traces of a grate-like floor between the firebox and the firing chamber were detected at kiln N2. The floor was made of clay and small pebbles. Obviously, the direction of the hot air draft inside the kiln was vertical, from lower to upper level.

No samples of ceramic production were discovered inside the kilns but about 20,000 pottery fragments were found nearby. In some cases the evidence of firing damage was clearly visible on the fragments – surface cracks and deformation. Most of the pottery samples are of a light orange color on the surface and in the fracture, without a dark core. This indicates uniform oxidation of the clay body. In some cases the surfaces and fractures of ceramic samples are of a black color caused by smudging. Preliminary thin-section analysis executed after the excavations has shown that the pottery was produced from a clay paste containing calcite inclusions. In general, raw calcareous clays are not characteristic for the research area, and this

case of calcite-tempered archeological ceramic paste is the only one known for the southern Russian Far East. Recent SEM-EDS analyses of several pottery samples conducted by the author confirm a high content of Ca in the ceramic body composition. In the elemental chemical spectra the Ca content varies from 3.0 to 40.0 percent.

The results of the Troitsa kiln site ceramics examination are interesting as regards suggestions about the firing temperature regime. Thin-section analysis revealed evidence of some degree of destruction, or decomposition, of the calcite matter occurring upon the heating. However, the decomposition process was not completed. Under SEM examination, evidence of initial vitrification of the clay matter was recognized in some cases (Fig. 11.2d) (Andreeva & Zhushchikhovskaya 1986; Zhushchikhovskaya & Nikitin 2014). Recent WA indexes measured for ceramic samples fired under an oxidizing regime varied mostly from 12.8 to 15.5 percent, indicating a relatively porous body. WA indexes for black, or smudged, samples were from 10.0 to 11.2 percent. However, the surface hardness index of the pottery samples is around 6.0–6.5, indicating a relatively high strength for the ceramic material.

Researchers note (Tite & Maniatis 1975; Leicht 1977; Shepard 1987: 22, 30; Bong et al. 2008; Palanivel & Meyvel 2010; Liu et al. 2013) that precise statements about firing temperature are far from always possible in the case of calcite or carbonate tempered pottery. The thermal behavior of calcareous ceramic paste differs significantly from that of a non-calcareous paste. The decomposition of calcite matter develops between 650°C and 898°C. After passing 898°C the fast and immediate decomposition of calcite occurs. If the firing is short and rapid no visible evidence of calcite matter changes may be noted before 750–800°C. The clay matrix vitrification process in calcareous pastes begins at about 30–60°C below the temperature of non-calcareous pastes. During thermal processing a calcite-containing clay body acquires a porous structure unaltered at high temperatures. The increase in firing temperature up to 850–900°C and above provokes the risk of ceramic body damage resulting from the “popping” of calcite particles. But if the firing schedule is conducted correctly, especially at temperatures above 750–800°C, the finished product is undamaged and of good quality, and in particular of relatively high surface hardness. In general, a crucial condition of successful firing of calcareous ceramic pastes is special attention to regulation of the temperature regime, which demands a high level of skill on the potter's part.

Considering these assumptions about the firing process of calcareous clays, the above analyses of the material from the Troitsa kiln suggest firing temperatures not higher than 800–850°C. Inside the fuel chamber the temperature was raised to more than 1000°C, judging from the melting of quartz grains in granite slabs of the chamber's facing walls. Based on the degree of oxidation of the ceramic

bodies, one can suggest a sufficient duration of firing time, providing an even thermal processing of the entire thickness of the ceramic pots' walls. The finished ceramic product had a relatively porous but strong body. Obviously, the technological cycle of calcite-containing-ceramics firing in Troitsa kilns was executed efficiently.

No analogues of Troitsa two-leveled kilns are known in the research area or the neighboring territory of the Korean peninsula. In China updraft firing kilns were used during the Shang period, later being replaced by long-type kilns in southern China and *mantou* type kilns in northern China (Gerritsen 2012; Kerr & Wood 2004: 314–34; Hein 2008). The geographically closest region for the use of vertical updraft round kilns with a furnace chamber dug into the earth, and with a grate separating fuel and firing chambers, is Central Asia, where these kilns were the basic firing structures for ceramic production from the Bronze Age to the Medieval period. The vertical kilns of Central Asia (Saiko 1982) shared a common line of development in firing structures with the kilns of the Near East, where this type was invented by 6000 BC (Simpson 1997a, 1997b; Saiko 1982). Theoretically, the idea of vertical updraft kiln construction might have been imported by the Mokhe people from those regions where this type of firing device was used. Most likely the region of origin was Central Asia. An indirect argument for this scenario may be the traditional high mobility of the Mokhe tribes and the close connections of some of them with populations in the Steppe Corridor. Obviously this idea needs further research. In particular, northeastern China is considered a prospective area for the search for probable evidence of kiln remains used in Mokhe pottery production.

11.4. Ancient States period: advanced kiln technology

11.4.1. Bohai Kingdom stage

This stage of the Ancient States period in the history of Primor'ye corresponds to the temporal framework of AD 698–926, when a large part of the research area was included as an administrative periphery in the territorial boundaries of the Bohai Kingdom. The capitals of the Bohai state were located in Manchuria, in modern northeastern China. However, archeological records of the Primor'ye Region show evidence of a relatively dense population and active economic and social life in this remote district. The kinds of local archeological sites attributed to the Bohai Kingdom period are the remains of walled settlements, village settlements and temples (Boldin et al. 2012; Dyakova 2014; Ivliev 2010). Two large groups of ceramic products are present – pottery for various functions and needs, mostly produced with the pottery-wheel, and architectural ceramics including roof tiles, roof ornaments and bricks. At present, two sites of the Bohai period containing the remains of kilns are known in the Primor'ye territory.

A famous site containing ceramics kiln structures is the Kraskino walled settlement located in southwestern

Primor'ye, not far from the seacoast (Fig. 11.1) (Gel'man 2005, 2016). This was an important administrative, transportation and trading center that supposedly played a significant role in communication between the Bohai Kingdom and the Early States of Japan. The first evidence of Bohai period firing kilns was discovered at the Kraskino walled settlement in 1980. From 1980 to 2005 the remains of large ceramics kiln assemblages were excavated at this site (Boldin & Nikitin 1999). One kiln assemblage was situated on the margin of the northwestern part of the Kraskino site, quite close to the ancient town's wall. The assemblage of kilns was located around the remains of a small building interpreted as the pavilion of a Buddhist temple. The excavations discovered a square platform 3.8 m by 3.8 m formed of pebbles and soil, the remains of a collapsed tile roof, and some items connected with the Buddhist cult. An ancient well was also excavated in this area (Fig. 11.3).

The remains of several structures situated at some distance from one another were distinguished (N1, 2, 3, 11, 12), as well as a group, or cluster, of structures (N4–10) located quite close one to another, in some cases covering each other. This situation indicates that kilns were built and exploited not simultaneously but during some temporal interval. In some cases later kilns were built on the site of destroyed early ones. The nine excavated structures have been definitely identified as sloping tunnel-like firing kilns embedded in the ground (Fig. 11.4). Three objects (N3, 9, 10) in a poor state of preservation cannot be interpreted clearly.

The kiln floors were embedded in the earth 0.3–0.8 m and inclined artificially at an angle of 10–15 degrees. The walls of the tunnels are made from earth and were reinforced with stones. In the case of kiln N1, the lower parts of the tunnel walls were faced with broken tiles. Three functional parts of the kiln structure may be recognized: the fuel (furnace, firebox) section at the tunnel's lower end, the flue section at the tunnel's upper end, and the firing section (fire chamber) occupying the most space in the tunnel, between the fuel and flue sections. The flue section of most of the kilns contained a burnt soil layer and ash deposits. In some cases the spots of burnt soil could be traced to the floor of the firing section. In the cases of kilns N4, 6, 8, there was a partition between the fuel and firing sections constructed of pebbles and broken tiles. In most cases a round pit 0.3–0.5 m deep was located in front of the fuel section. At several kilns the remains of a tube-like chimney built of pebbles were discovered at the upper end of the tunnel. In the case of kiln N4, traces of two chimneys were unearthed. The length of the kilns, without the pit near the furnace, varied from 3.3 m to 5.1 m, and the maximal width varied between 1.6 m and 3.0 m.

The kilns' superstructures were totally destroyed. The large number of amorphous pieces of fired clay with the traces of burnt plant inclusions found around the kiln remains are interpreted as fragments of vault-like superstructures. The only excavated evidence of ceramics production

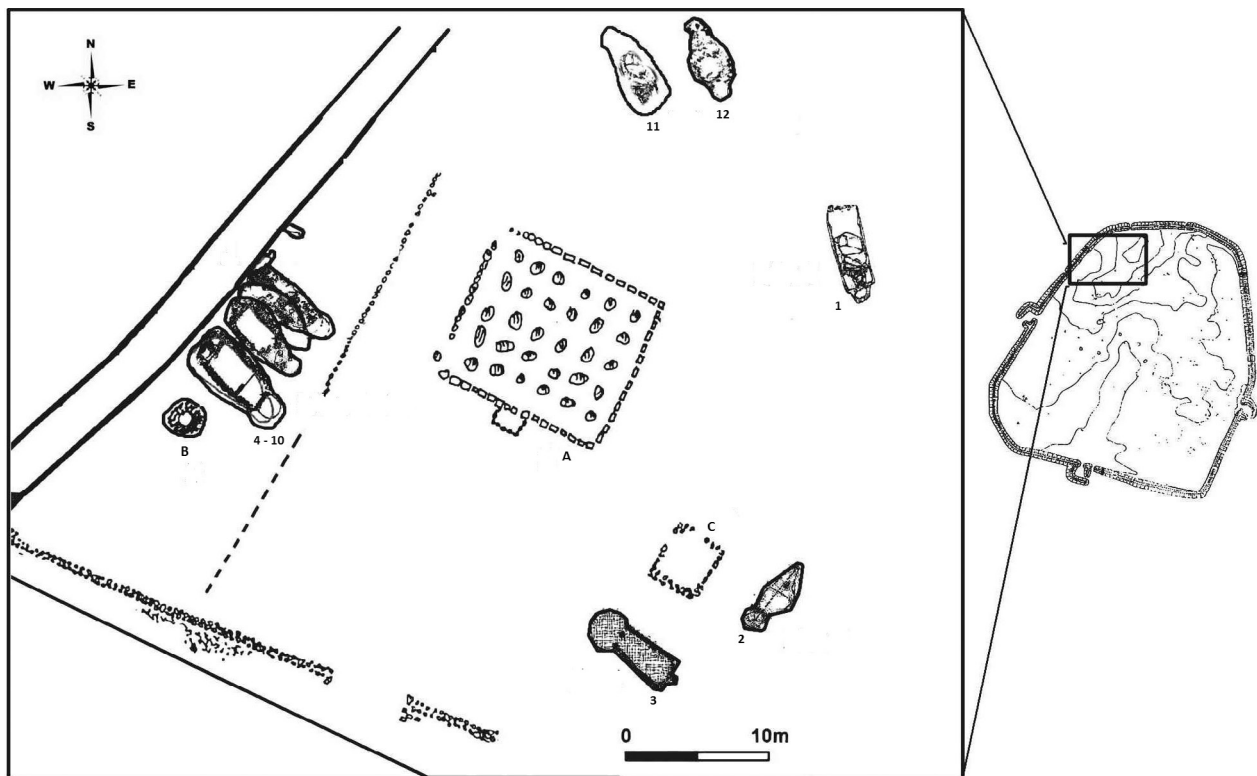


Figure 11.3. Kraskino walled settlement. Location of the kiln complex. 1–12: Kilns and kiln-like structures. A: Temple platform remains. B: Well. C: Remains of a small platform (from Zhushchikhovskaya & Nikitin 2014).



Figure 11.4. Kraskino walled settlement. Remains of kiln N4 in situ (from Zhushchikhovskaya & Nikitin 2015).

connected with the kiln remains are roof tiles. Samples of tiles – but not in large number – were found inside and outside kilns N1, 4, 5, 6, 8. A series of samples of ceramics spoilage were discovered. These are tiles with traces of deformation, cracking, swelling and surface melting. Tiles from the remains of the kilns are very similar in their morphological features to tiles unearthed in the area of the temple pavillion. The kilns were presumed to be destined first for serving the need for roof tiles for the construction and further restoration of temple buildings.

Some preliminary information about firing conditions in the Kraskino kilns, in particular the temperature regime, may be obtained from examination of the tile samples (Table 11.1). The correlation of data on WA testing, surface hardness measurement and SEM-EDS analysis will indicate temperature regimes applied in firing tiles. The highest temperatures are supposed for only a few samples – tile fragments of an even gray surface color and fracture, and with a relatively dense and hard body. The WA index of these samples is 6.2–6.5 percent. This is characteristic of a relatively low-porosity ceramic body produced by high-quality firing (Avgustinik 1975: 221–22). The surface hardness index of these samples is high – around 7.0. SEM-EDS analysis of a sample with a WA index of 6.2 percent indicated evidence of an extensively vitrified ceramic microstructure with a non-calcareous, low refractory clay matrix (Fig. 11.2e). Vitrification of this extent may be achieved in this kind of clay at temperatures of 900–50°C, or even somewhat above, under an oxidizing atmospheric regime. Under a reducing regime, vitrification processes occur at

Table 11.1. Summary of properties of kiln-fired ceramics in Primor’e region, southern Russian Far East described in the text. Stars (*) indicate sites with excavated kiln remains

Period-Date	Culture-Site-Date	Physical Properties of the Ceramic Bodies				
		Degree of ceramic body vitrification (under SEM analysis)	Water absorption index (Open porosity index) %			Surface hardness (Mohs scale)
			High	Moderate	Low	
PALEOMETAL period, IX–VIII c. BC–IV	YANKOVSKAYA culture Malaya Podushechka site*	–	no data	no data	no data	no data
	YANKOVSKAYA culture Novyi Mir, Solnechnyi Bereg, Cherepakha-7 sites	No vitrification Initially vitrified	16.0 – 18.9	9.2 – 15.6		3.0–4.0
	KROUNOVSKAYA culture Chernyatino-2 site* (ca. 3rd–4th century AD)	Initially vitrified and extensively vitrified		7.4–13.1		no data
PRE-STATE period, IV–VII c. AD	MOKHE culture Troitsa kiln site*	No vitrified and Initially vitrified		10.0–15.5		6.0–6.5
BOHAI STATE period 698–926	Kraskino walled settlement*	No vitrified and initially vitrified Extensively vitrified		9.2–12.0	6.2–6.5	5.0–6.0 6.5–7.0
JIN/DONG XIA STATES period 1115–1234	Sergeevka kiln site*	No vitrified Initially vitrified Extensively vitrified Almost totally vitrified	14.5–19.1	10.0–14.2	4.2–5.8 0.7–3.0	4.0–5.0 no data 7.0–8.0

temperatures of no less than 50°C lower (Day et al. 2006; Maniatis 2009). So, in the case considered the supposed firing temperature is between 850 and 900°C or slightly above.

More common are gray and sometimes yellowish tiles with a “softer,” more porous body. The WA index of this series of samples ranges from 9.0 to 16.2 percent, that is, corresponding mostly to the moderate level. In most cases the surface hardness index is 5.0–6.0. SEM-EDS analysis of several samples with a WA index of 9.9 to 11.7 percent indicates that vitrification of a non-calcareous, low refractory clay matrix is in its initial stage (Fig. 11.2f), or not quite attested. The analyses show an initial vitrification in low refractory clays corresponding mainly to firing temperatures of 800–50°C under an oxidizing atmosphere, and a somewhat lower temperature under a reducing atmosphere. The absence of evidence of the vitrification process in the clay microstructure indicates firing temperatures under 800°C (Bjork 1995: 52–57; Day et al. 2006: 152–56; Maniatis 2009).

Thus, it may be supposed that the ceramics kilns of the Kraskino walled settlement worked mainly within the interval 800–900°C or a little above. This consideration is roughly confirmed by the examination of gray wheel-made pottery from the Kraskino site and some other Bohai sites of the research area (Zhushchikhovskaya 2017). Most common in pottery assemblages are samples with a WA index of 9.0–11.5 percent. Evidence of initial

vitrification of a non-calcareous low refractory clay matrix is revealed by SEM-EDS analysis, indicating probable firing temperatures around 800°C or a little above under a reducing atmosphere. In rare cases pottery samples have a low WA index of 5.8–8.2 percent, indicating probable higher firing temperatures. Certain samples show extensive vitrification of the clay matrix probably caused by temperatures of 850–900°C under a reducing atmospheric regime (see Table 11.1).

Another set of remains of Bohai period firing kilns was detected in the mainland part of the southern Primor’e Region, in the Krounovka River valley (Fig. 11.1). The fragmented remains of five firing structures were excavated near the river, close to a settlement (Korsakovskoe-1 site) and to a neighboring Buddhist temple (Korsakovskoe-2 site). Radiocarbon dates for the kiln structures closest to the temple are: 1500±160, 1030±40, 1090±35 BP (Kuzmin et al. 2005). All kilns were substantially damaged, though the main structural features can be recognized. These are the elongated plan, the slightly sloped floor deepened into soft alluvial soil to 0.7–1.3 m, and the structural division into three parts – fuel section, firing section and flue section. The maximal length of a kiln’s tunnel was about 4.0 m in one case. In other cases the length varied from 2.5 m to 3.5 m. The floors and walls were covered with a layer of dense, burned clay. In two cases traces of a tube-like chimney formed of clay and pebbles were unearthed. In three cases the remains of collapsed domes formed of burnt clay mixed with straw were discovered. The inside area of the excavated kilns showed no signs of ceramics

production. However, some fragmented tiles were found near the remains of the kilns.

Sloping tunnel-like ceramics-firing kilns unearthed at the Bohai sites in Primor'e, at the Kraskino walled settlement, seem at first to be very similar in main construction principles to sloping tunneled, or climbing, kilns that were invented on the neighboring Korean peninsula in the third to fourth centuries AD, during the Three Kingdoms period, and widely used from that time up to the recent past (Rha 2006: 111–12; Kim 2013; Lee 2007, 2015; Barnes 2001: 92–124). As some researchers suppose, the main construction idea of Korean tunneled kilns goes back to long, or dragon, kilns that originated in the Yangtze basin in the first millennium BC. Later, this kiln construction was adopted in many regions of East and Southeast Asia (Kerr & Wood 2004: 347–64; Hein 2008). Kilns at Bohai sites in Primor'e may be considered the northeastern-most case of the spread pattern of the sloping tunneled kiln type.

Comparing the kiln structures excavated at the Bohai sites of the southern Russian Far East with the neighboring Korean sloped tunneled kilns, one can note certain differences in their sizes and firing conditions. The kilns of the third to sixth centuries, which are somewhat older than the Bohai kilns of Primor'e, had a tunnel length of 6.0–10.0 m (Kim 2013; Lee 2015). That is certainly more than the tunnel lengths of the Primor'e kilns described above. Also, the stable firing temperatures achieved in tunneled kilns of the Korean peninsula during the Three Kingdoms period were 900–1000°C, and sometimes up to 1100–1200°C. These kilns produced high-quality gray ceramics, which are considered similar to stoneware (Barnes 2001: 117–24; Rha 2006: 33–35; Lee 2015).

Our SEM-EDS examination of a small series of pottery samples from Baekje, the Neungsanri-saji site, dated to the sixth/seventh centuries, confirms the opinion of an advanced technical and technological level of firing process in ceramics kilns of the Three Kingdoms period. The samples show different levels of structural transformation and vitrification of the fired clay matrix, indicating a wide range of temperature regimes – from 750–800°C to 1050°C and somewhat above (Fig. 11.2g). Accordingly, the Baekje kilns produced ceramics of a different quality – ordinary earthenware with porous body and a “hard” ware with highly vitrified body (Zhushchikhovskaya 2017).

It may be concluded that the kilns of the Bohai sites in the Primor'e territory belonged to the same type as or a type very similar to the Korean kilns of the first millennium AD but were characterized by smaller sizes and less technical potential. It may be supposed that this indicates a later appearance and slower development of advanced firing technologies in the area considered.

11.4.2. Jin/Dong Xia State stage

From 1115 to 1233 the Primor'e Region was, first, included in the Jin Empire (1115–1234) that was

established by warlike Jurchen tribes as its northeastern peripheral boundary. Northern China, conquered by Jurchens, was the primary territory of the Jin Empire, where the political, administrative and economic centers were located. In the last stage of the Jin Empire a separate state formation named Dong Xia existed in Manchuria and the Primor'e territories from 1215 to 1233. In the research area the Jin/Dong Xia period is represented by numerous archeological sites reflecting various aspects of life in the Jurchen population. The remains of walled settlements, fortified settlements and temples belonging to the Jin/Dong Xia stage have been discovered and excavated throughout the research area. The remains of high-status courtyards, column-type buildings, metalworking workshops and commoners' houses were discovered in the walled settlements of Krasnyi Yar, Shaiga, Nikolaevka, Anan'evka and others. In a few cases the remains of isolated architectural complexes located outside the walled settlements and settlements were unearthed and recognized preliminarily as Buddhist temple sites. Features of Jurchen town planning, building and architectural standards and technologies were influenced greatly by Chinese cultural traditions. Artifact assemblages from Jurchen sites are rich in various kinds of metal tools, weaponry, ornaments, household utensils, coins, imported glazed stoneware and porcelains (Artemieva and Usuki 2010; Ivliev 2010; Li et al. 2018).

Ceramics artifacts of two main groups are common at Jurchen sites. The first group is day-to-day pottery mostly made on a potter's wheel: storage vessels, kitchen needs, table service and objects with technical functions. The second group is architectural ceramics that include roof tiles, bricks and sculpted objects for roof decoration. The concentrations of architectural ceramics are connected mainly with the remains of high-status buildings such as palaces, administrative offices and temples. Most of the ceramics of both groups are gray on the surfaces and in the fractures, indicating firing in special kiln devices under a reducing atmospheric regime. Obviously, the large amounts and qualities of day-to-day pottery and architectural ceramics from Jurchen sites indicate workshop production. Although archeological evidence for ceramics workshops has not been detected within the excavated walled settlements, single cases of ceramics kiln remains are known. The most interesting case is the Sergeevka site on the southeastern mainland of the Primor'e Region, in the valley of the Partizanskaya River, not so far from the two large Jurchen walled settlements of Shaiga and Nikolaevka (Fig. 11.1). The remains of several kilns were detected on the bank of Sergeevka Creek in the vicinity of the modern village of the same name and at a distance of about 2 km from deposits of high-quality potter's clay (Vasil'ev 2009; Zhushchikhovskaya & Nikitin 2017).

The remains of two fragmentarily preserved kilns (N1 and N2) situated at a distance of a little more than 6.0 m apart were excavated. Both are of the same construction type: a single firing chamber built of bricks with a “horseshoe”

horizontal floor plan. In the case of the better-preserved kiln N1, the brick walls of the firing chamber were traced to a height of up to 1.5 m. The firing chamber floors were formed of very densely packed earth. According to excavation data, the firing chamber floor of kiln N1 had a length of 1.97 m and maximal width of 1.67 m. The firing chamber floor of kiln N2 was partially preserved, with a length of 2.4 m. The maximal width of the firing chamber floor was 2.24 m. The inner surfaces of the brick walls were of a dark gray color probably indicating a carbon-saturated reducing atmosphere. No traces of melting activated by the long-term impact of high temperatures on the inner surfaces of the brick walls were detected. The yellowish and light orange outer surfaces were oxidized in the open air.

In the case of kiln N1, traces of a furnace chamber located at the narrowest side of the firing chamber below floor level were revealed. In the cases of both kilns, evidence of flue channels was unearthed at the bottom of the firing chamber's back wall. They were probably joined to a chimney tube at the back of the kiln. However, the areas behind the back walls of both kilns had been destroyed, and no traces of chimneys could be detected. In the case of kiln N2 the lower part of the back wall was better preserved. Six standard flue channels of 0.08 m in height and 0.16–0.17 m in width had been constructed under the floor. In the case of both kilns, several rows of the bricks were located longitudinally on the floor from the furnace chamber to the back wall of the firing chamber. The superstructures of both kilns had been completely destroyed. An accumulation of burnt clay pieces, fragmented tiles and bricks was unearthed at the level of the upper part of the firing chamber walls of kiln N1. Obviously, these were the remains of the kiln's superstructure, which may be supposed to be some kind of dome formed of bricks, tiles and clay.

The firing chamber of kiln N1 was completely filled with fired tiles arranged in piles situated on rows of bricks on the floor. These rows obviously served as supports for the piles of tiles during the firing process. The total number of tiles inside the firing chamber of kiln N1 was 1840. The tiles had not been unloaded, and it may be supposed that the firing process in this kiln had not been completed.

Along with the tiles found inside kiln N1, a large series of broken and sometimes whole tiles was collected in the vicinity of the kilns. The tiles from the Sergeevka site are similar in their morphological standards to tiles common for the Jin/Dong Xia walled settlements in the research area. The characteristic features are: semi-cylindrical shape, a length of 30–31.5 cm, a width of 20–21 cm, and in some cases one arc-curved end decorated by finger-stamped roundish and oval impressions.

An examination of the tile samples from kiln N1 and the tiles collected nearby provides data on temperature and the atmospheric regimes of firing (Zhushchikhovskaya &

Nikitin 2017). Most of the tiles from kiln N1 are of a yellowish and pale orange color on the surface and in the fracture, indicating an oxidizing firing regime. The WA index has high values of 14.5–19.1 percent, and the surface hardness index is 4.0–5.0. SEM-EDS analysis was applied to four samples. It was revealed that the microstructure of the ceramic body has an amorphous pattern without any evidence of a vitrified clay matrix (Fig. 11.2h). These data allow the supposition that the temperature during the last firing in this kiln was not above 800°C.

The tiles collected in the area of the kilns are mostly of a gray or dark gray color, sometimes of a light orange color and differing in their quality. Some of them have traces of firing damage, deformation, cracking and surface melting. Some samples have a very dense body with an even gray or bluish-gray color, looking like “stoneware.” The WA indexes of these samples are 0.7–3.0 percent, and the index of surface hardness is 7.0–8.0, indicating a high firing temperature. SEM-EDS analysis of four samples with WA indexes of 0.7–2.7 percent reveals microstructures with a highly, or continuously, vitrified non-calcareous clay matrix (Fig. 11.2i). Taking into account a reducing atmosphere for the firing, which accelerates the vitrification process, it seems correct to determine a firing temperature of around 950°C or somewhat above.

Two gray-colored samples with WA indexes of 4.2 and 5.8 percent indicate microstructures with an extensively vitrified non-calcareous clay matrix (Fig. 11.2j). The estimated firing temperature for low refractory clays under a reducing regime is around 900°C. Microstructures with an initially vitrified clay matrix were detected for series of samples with WA indexes of 10.0–14.2 percent (Fig. 11.2k). The supposed firing temperature in this case is 800–850°C or slightly above.

In general, the approximate interval for working temperatures in the Sergeevka kilns is thought to be from 800–850°C to 950°C or somewhat above. It seems likely that two atmospheric regimes – oxidizing and reducing – were applied to the firing process. The case of kiln N1 indicates that an oxidizing atmosphere was initially conducted for a certain amount of time during firing. However, in the final stage of the firing the oxidizing regime might have been changed to a reducing regime. This conclusion is based on the dark gray color of the inner surfaces of the brick walls in the firing chambers of kilns N1 and N2, like the gray and dark gray color of most of the tiles found in the vicinity of the kilns.

Data on the examination of wheeled pottery from various Jin/Dong Xia sites (Zhushchikhovskaya 2017) roughly confirm the above conclusions on firing temperature and atmospheric regimes. In only a few cases can one note samples of a relatively low WA index of 6.0–8.3 percent. The WA index for most is within the limits of 10.0–14.0 percent. For some samples with a WA of 10.0–11.5 percent, SEM analysis indicates initial vitrification of the clay matrix. Based on these data it may be supposed that

the potteries were usually fired at temperatures of 800–900°C, though in rare cases at higher temperatures. The gray color of most of the pottery samples at each Jurchen site indicates firing in a reducing atmosphere, at least in the final stage.

The results of excavations at the Sergeevka site and recent field observations in this area (Zhushchikhovskaya & Nikitin 2017) allow the supposition that a tile-making workshop, including an assemblage of firing kilns, was located in this place. An important factor favorable for the ceramics and tile-making is the close availability of good-quality clay raw material resources and coal deposits that can be considered as fuel resources for the firing process. This area of the Partizanskaya River valley is rich in coal deposits. In particular, these deposits are known in the vicinity of Sergeevka village, a distance of 3–5 km from the kiln site (Anert 1928; Zonn et al. 2016: 115). The Sergeevka kilns are quite similar in their structural features (Fig. 11.5) to the well-known brick-built *mantou* kilns first invented in northern China around the middle of the first millennium AD (Guo 2000; Kerr & Wood 2004: 314–34, 428–43). The *mantou* kiln type is characterized by a single firing chamber with a high dome-like roof and “horseshoe” horizontal plan. The firing chamber had a floor area of up to 10 m² and more. Hot air came in from the furnace

chamber located beneath the floor level at the front of the kiln, then moved up and down to the flue channels located in the bottom part of the back wall. The flue channels were joined to the chimney or pair of chimneys behind the back wall. Chinese *mantou* kilns operated at high temperature regimes of more than 1000°C, up to 1100°C for stoneware production, and up to 1300°C for porcelain production. Over the course of time this kiln type became widespread in the ceramic production of northern China, and was also adopted in southern China. According to archeological investigations in northern China, *mantou* kilns were located in clusters in areas with available potter’s clay resources. After about the tenth century coal replaced wood as fuel for firing ceramics, and the vicinity of this resource became a very important factor in the location of tile- and brick-making kilns.

Earlier, researchers noted that Haicheng in the Liaoning Province was the northeastern point of production by *mantou* kilns (Kerr & Wood 2004: 330). From this perspective, the Sergeevka site may be interpreted as the northeastern-most appearance of a *mantou* kiln. It may be supposed that firing kilns of *mantou* construction appeared in the Primor’e Region during the Jin Empire period (1115–1234) through influence from a northern Chinese culture of ceramics production. At present, the Sergeevka site is the only known evidence of a *mantou* production complex of kilns in the territory of Primor’e. Obviously, the combination of factors such as water, clay and fuel resources, and the proximity of large Jurchen walled settlements determined the choice of this place for the location of kilns for firing ceramics.

Evidence of structures that may theoretically be interpreted as firing devices was discovered at the Jurchen site of the Lazovskoe walled settlement located about 50 km north of the Sergeevka kiln site (Fig. 11.1) (Len’kov & Artemieva 2003). The remains of a probable workshop area were excavated inside the ancient town, on the hill slope. The workshop was a clearly demarcated 50 m by 50 m square area surrounded by an earthen wall with a gate-like break on one side. The remains of nine kiln-like structures were compactly located in the eastern part of the workshop area, near the remains of some subsidiary structures resembling a shed and a storehouse along with several pits. In the western part of the workshop area the remains of a habitation structure were recorded. All of the kiln remains are recognized as elongated trenches 6.0–7.0 m in length and 0.8–1.0 m in width, embedded in the ground to a depth of 0.5–0.6 m. At one end of each trench there was a furnace pit reinforced with stones, and a roundish pit for holding kiln waste products was joined to the furnace pit. Furnace pits and pits near them were filled with charcoal. The firing chambers had a length of 5.5–6.5 m and compact floors covered with a burnt clay layer 0.002 m thick. The flue section at the rear of each trench appeared as a pit 0.4–0.5 m in diameter and 0.6 m in depth; flues were clearly of a tube-like type. The floors of some kilns were slightly sloped, with the flue section at the upper level and the furnace section at the lower level. Other kilns

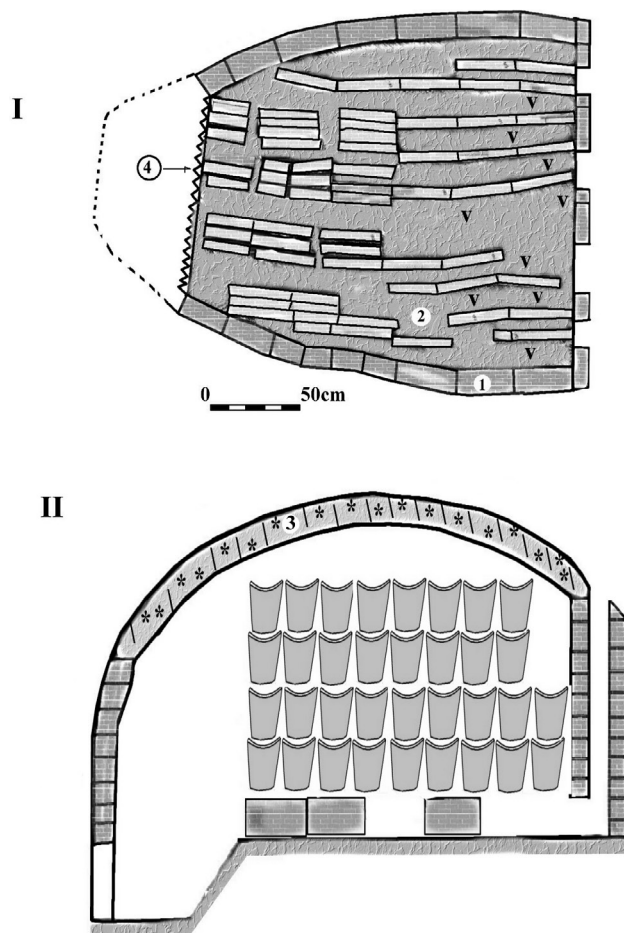


Figure 11.5. Sergeevka kilns site. I: Plan of the floor area of kiln N2. II: Graphical reconstruction of the profile section of kiln N2 (from Zhushchikhovskaya & Nikitin 2015).

had horizontal floors. The kilns' superstructures had been destroyed, but, judging from the fragmentary remains, they were built of clay on a wooden framework.

No ceramic production pieces or spoilage samples were found inside or outside the kiln-like structures. However, the burnt clay layer on the floor of the trenches and the presence of charcoal in the furnaces and pits in the furnace area indicate that the kilns were actually used for the thermal processing of certain products, probably ceramic items.

11.5. Concluding remarks

Archeological records of the history of kilns for firing ceramics in the southern Russian Far East date roughly to the period from the mid first millennium BC into the first half of the second millennium AD. In general, the development of the technique and technology of kilns was part of the cultural, social and economic history of the region. The dynamics of ceramics kilns are presented through their construction and technological features (Table 11.2, Fig. 11.6). It is important to note that the history of kilns presents not a gradual development of a certain construction type, or model, but rather the changing of various construction types.

Initially, kiln-like devices were invented and exploited in this area during the Paleometal period, which covered the first millennium BC and first centuries AD. The appearance and adoption of the earliest pottery-firing kilns were supposedly closely connected with the introduction of the first metal artifacts and some knowledge and skills in metalworking and thermal processing in the southern Russian Far East and neighboring areas of East Asia. The simplest tunnel-like construction of a pottery-firing kiln

excavated in the western Primor'e Region (Chernyatino 2 site) may be considered as evidence of some kind of cultural interaction with the population of the Korean peninsula, where tunnel-like firing kilns were exploited from the first half of the first millennium AD.

Further history of ceramics kilns demonstrates an abrupt change in the construction type of the firing device. Two-level updraft kilns discovered at the Troitsa site, attributed to the Pre-State period of the fourth to seventh centuries, belong to a construction model unusual in East Asian territory in the first millennium AD. A preliminary explanation for the appearance of this kiln type in the research area may be cultural impulses from remote territories of Central Asia, where this firing construction is a traditional one from the distant past.

The wide distribution of kiln-fired ceramics in the southern Russian Far East is connected with the Ancient States epoch, seventh to thirteenth centuries, when well-developed firing kilns with a reducing atmospheric regime and temperature regime of up to 900–1000°C were exploited. Two construction types of firing kilns are distinguished for the Ancient States epoch in the southern Russian Far East. The tunneled, or climbing, kiln was characteristic for the Bohai State period, then the *mantou* kiln appeared in the Jin/Dong Xia period. Both types may be interpreted as derivatives of firing-kiln constructions used in the ceramics production of the Korean peninsula and northern China in the first millennium AD. The processes of Ancient States formation and development in East Asia and the Far East also brought about some technological and technical innovations and inventions in peripheral areas. It may be noted that the kilns of the Bohai and Jin/Dong Xia periods in the study area were characterized by relatively small sizes in comparison with the kilns of

Table 11.2. Types of old ceramics-firing structures from the southern Russian Far East

Chronology - Cultural Context	Type of Firing Structure - Building Materials	Temperature - Atmospheric Regimes
Paleometal period – Yankovskaya culture – 9th/8th – 3rd/2nd centuries BC	Oven-like single-chambered, ground-level crossdraft kiln – clay on plant framework	approx. 700–850°C – oxidizing
Paleometal period – Krounovskaya culture – ca. 4th/5th centuries BC – 4th/5th centuries AD	Most simple variant of tunnel-like sloping crossdraft kiln – clay on wooden framework	approx. 750–900°C – oxidizing – smudging
Pre-State period – Mokhe culture – ca. 4th – 7th centuries AD	Two-level updraft kiln with underground fuel chamber and dome-like firing chamber – stone, clay	approx. 800–850°C – mostly oxidizing – smudging
Ancient States period – Bohai Kingdom – 698–926	Tunnel-like, sloping crossdraft kiln – stone, clay	approx. 800–900°C – reducing – oxidizing – smudging
Ancient states period – Jin/Dong Xia state – 1115–1234	Mantou type downdraft kiln – bricks	approx. 800–950°C – mostly reducing – oxidizing

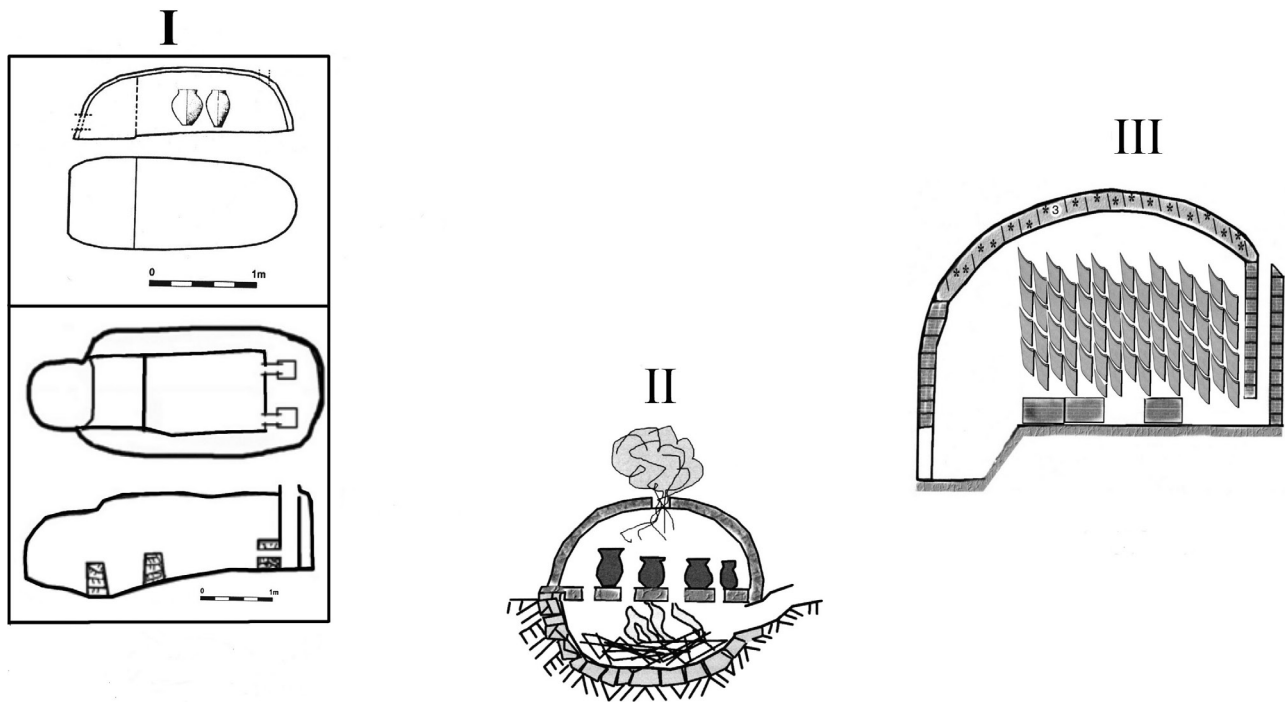


Figure 11.6. Construction types of ceramics-firing kilns in the southern Russian Far East. I: Tunnel-like cross-draft kiln. II: Two-level vertical updraft kiln. III: *mantou* type down-draft kiln (from Zhushchikhovskaya & Nikitin 2015).

the Korean peninsula and northern China. The technical potential indicated by the firing temperature regimes of tunnel kilns and *mantou* kilns in the territory of Primor'e seem to be inferior to that of kilns with a sloping tunnel of the Korean peninsula and the Chinese *mantou* kilns.

All known cases of ceramics kilns dated to the Ancient States epoch in the territory of Primor'e are represented by the remains of kiln clusters, or workshops. The excavated kilns were directly related to the firing of roof tiles. It may be supposed that the primary reason for the development of firing kilns on the periphery of the Bohai Kingdom and later in the Jin Empire was the need for architectural ceramics (tiles, bricks and decorative features) for high-status buildings (administration offices, palaces and temples). It is likely that the ceramic ware serving various needs in daily life was produced locally and fired in the same or very similar kilns. Firing technology, including atmospheric and temperature regimes, was the same for architectural ceramics and pottery. The finished products – tiles and pottery – were similar in such characteristics as water absorption, density and hardness. It is to be expected that in the future direct evidence of kiln firing of pottery will be discovered.

Archeological records of the post-Ancient States period in the Primor'e Region are very poor and infrequent because of the desolation and depopulation caused by the Mongol conquest in 1234. The remains of large settlements attributed to the fourteenth to fifteenth centuries and later times are not known. Accordingly, there is no evidence of ceramics production and firing kilns for the periods following the fall of the Jin and Dong Xia states.

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Pottery Kilns of the Khitans in Mongolia

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Abstract: After the Xiongnu Empire, new style kiln-fired ceramics were found from the Göktürks (552–744 AD) and the Uyghur Khaganate (744–840 AD). These may have been produced using kilns, but no production site has yet been discovered. It is possible that kilns were also used in other eras, but excavated items have thus far failed to confirm this possibility. For these reasons, it is difficult to conduct a diachronic study on pottery production in Mongolia at present. This essay provides an overview of our investigations of pottery kiln ruins at the site of the Chintolgoi Castle, built by Khitans, and discusses how this example should be placed within the wider context. Based on a detailed examination of the pottery, it is presumed that the pottery production at Chintolgoi Castle was an amalgamation of pottery traditions of different origins, such as those of the Bohai and Uyghur. It can be said that the relics of the material culture of the Khitan people reflected the state of “imperial” rule by which the Khitan people commandeered and reorganized the groups and technologies of other ethnic groups in the region as they expanded their territory.

Keywords: Mongolia, Khitans, Chintolgoi Castle, Bohai, Uyghur

12.1. Introduction

The ruins of only three types of pottery kilns have been found in Mongolia to date: those of the Xiongnu, the Khitans and the Northern Yuan dynasty. Since earthenware and stoneware were also found from the Göktürks (AD 552–744) and the Uyghur Khaganate (AD 744–840), these may have been produced using kilns, but no such ruins have yet been discovered. It is possible that kilns were also used in other eras, but excavated items have thus far failed to confirm this possibility. For these reasons, it is difficult to conduct a diachronic study on pottery production in Mongolia at present. This paper will provide an overview of pottery kiln ruins at the site of the Khitan Chintolgoi Castle, which we investigated, and discuss how we may position this example within the wider context.

Archeological research on the Khitans has concentrated on the study of the tombs of nobles and the city walls, and not on other products. The research on pottery has mainly focused on the chronology of pottery excavated from the tombs of nobles. The pottery of the Khitans is known to consist of soft earthenware, kiln-fired stoneware and porcelain. However, there has been no survey of the production sites of any of these pottery types, and an analysis of production techniques and a distribution have not yet been carried out. Therefore, the examination of the kilns at Chintolgoi Castle is of significance to the history of the Khitans. In addition, the kilns of the Khitans were more developed than those of the Xiongnu and Bohai, which is also meaningful when considering the changes in kilns in North Asia.

12.2. The advance of the Khitans into the Mongolian Plateau

In Chinese history books, the Khitans emerged around the fourth century AD. They were nomadic people inhabiting the basin of the Xar Moron and Laoha rivers, tributaries of the Liao River. The Khitan people had been divided into various groups, but Taizu (AD 872–926), also known as Abaoji, unified those groups and founded the Liao Dynasty (AD 916–1125). After assuming power, he extended his influence eastward, destroyed the Bohai (AD 926), and advanced southwards, eventually gaining control of the Sixteen Prefectures. He then advanced into the Mongolian Plateau. Because the Hexi Corridor (also known as the Oasis Route, or the Gansu Corridor) was controlled by the Western Xia (also known as the Tangut Empire), Taizu sought to establish a trade route with the countries to the west via the Steppe Route extending from the Mongolian Plateau. There was no unified Mongolian nation during this period, and the region was controlled by nomadic groups such as the Zubu and Yujue; the Khitans had to suppress these nomadic groups in order to establish the Steppe Route. To this end, in 1004, Emperor Shengzong of Liao established the Zhenzhou Military Base in what is now Bulgan Province, Mongolia, as well as three provinces, namely Zhenzhou (supervised by a military commissioner), Fangzhou and Weizhou (supervised by a provincial governor). He stationed 20,000 cavalries in the area, and placed 700 Han Chinese, Jurchens and Bohai settler households in the region to govern the Mongolian Plateau.

In the process of expanding his territory, the emperor settled groups from different cultural and social backgrounds,