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The salt industry remains at Nanheya Site in Dongying City, Shandong

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Abstract

In Match through June 2008, the Department of Archaeology, Shandong University and other institutions conducted excavation to Locus I of salt-producing workshop sites of the Western Zhou Dynasty at Nanheya, Dongying City. The recovered salt-producing workshop consisted of brine well, raw salt-condensing lot, salt furnace, brine adding pit, house foundations and stoves, and other remains related to salt-producing. The artifacts unearthed in the excavation were made of pottery, stone, bone and clamshell, among which the pottery took the bulk. In addition, large amount of clamshells, conch shells and some animal bones were also found. The typological features of the artifacts showed that this salt-producing site was built and used around the Middle Western Zhou Dynasty. The excavation to Nanheya Site is academically valuable for the researches on the salt industry in the coastal regions of northern Shandong during the Shang and Zhou Dynasties.

Keywords: Nanheya Site (Dongying City, Shandong); salt industry-history-Western Zhou.

Introduction

The Nanheya Site is located near Nanheya Village in the Team III, Branch I, Guangbei Farm in Dongying City, Shandong Province, 14km to southwest of the Laizhou Bay. The site covers 4sq km and includes 60 or more loci. In order to ascertain whether this site was an ancient salt production workshop, the Research Center of Oriental Archaeology of Shandong University conducted excavations from March to June in 2008. The excavations took place in the eastern portion of Locus 1 (covering an area of 2ha.), which was 250m to the north of the village, and uncovered over 900sq m (Figure 1). There they exposed a large-scale workshop feature relating to salt boiling from the Western Zhou era – about 3000 BP (Figure 2), yielding an important set of early salt production remains.

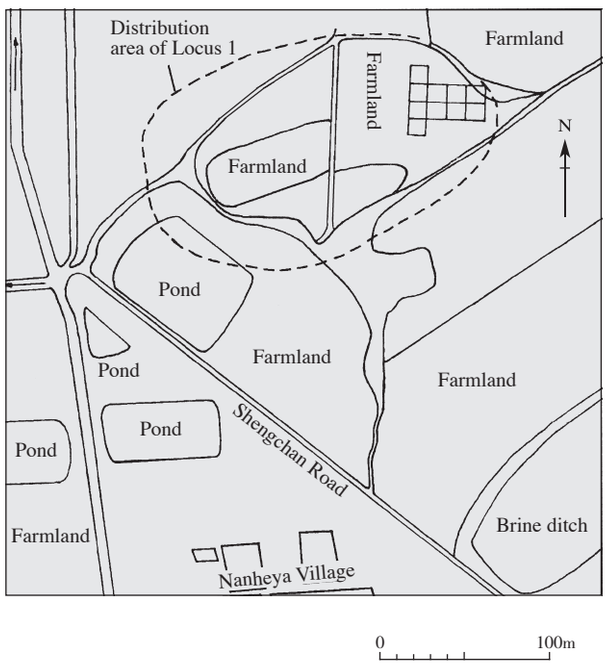

Figure 1 The location of Nanheya Site.

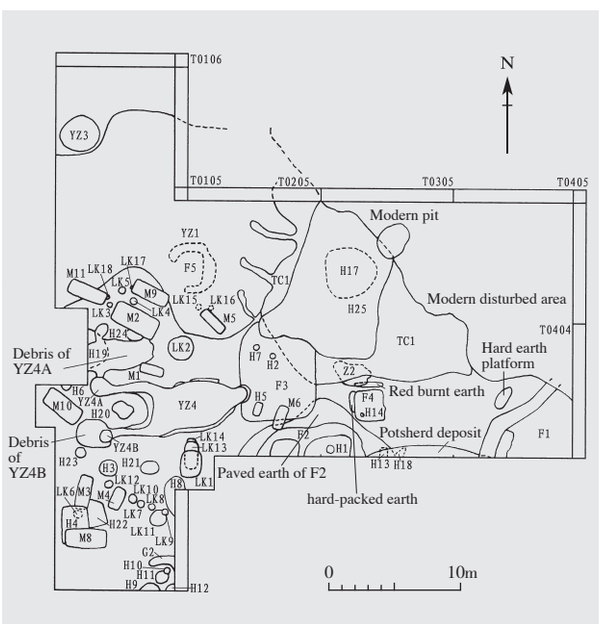

Figure 2 The location of Locus 1 in Nanheya Site and the excavation grids.

The remains

1. Brine pits: two of them (H25, H17) were recovered. H25, located to the north of center in the excavation area, was an irregular rectangle with a damaged north section. The pit was 10m long (remaining) and 6.8 to 9m wide, for a total coverage area of 68sq m, and 1.6m deep with a curved base. The contexts of the pit could be separated into three layers, which were gray or black-grey and yellow fine sand containing large amounts of red burnt earth and fragments of wood charcoal. H17, located to the north of H25, was nearly circular with a diameter of 3.8m and 3m deep. The pit contained black and bluish-grey fine sand, and a relatively large proportion of clay, the texture of which was quite dense. These two pits contained relatively large numbers of fragments of helmet-shaped pottery vessels (*kuixingqi*), jars, *li*-cauldrons, *gui*-tureens, as well as a few animal bones and shells (Figure 3).

2. Salt-drying floor: one example (TC1) was found. This feature was located in the vicinity of pit H25. It had an irregular plan and the remaining area was around 20sq m and the thickness was 0.6m. The floor could be subdivided into 4-6 thin layers, each being more or less parallel to the others. All of these strata are composed of black-grey plant ash 2 to 4cm thick. The plant ash layers can be further divided into many thin laminations, each of which was less than 0.1cm thick and the surface of each had a thin white crust, the thickness of which was also less that 0.1cm. Below each level of plant ash was a layer of red burnt earth about 10cm thick. Numerous fragments of helmet-shaped pottery vessels and small numbers of sherds of other pottery vessels such as *li*-cauldrons, *gui*-tureens, basins and *yan*-steamers were found in these strata (Figure 4).

3. Salt furnaces: three of them (YZ1, YZ3, YZ4) were recovered. Furnace YZ4 was located west of TC1. It was a Y-shaped slender feature that covers an area 30sq m in size and 20-80cm deep. The feature consisted of a firebox, a furnace entrance and flues. The walls surrounding the feature had been baked to a light red color, and parts of it were reinforced with partial helmet-shaped pottery vessels. The fill of the feature contained large amounts of red burnt earth and a small amount of plant ash. The furnace entrance in the easternmost of the feature was oval shaped, and had a base baked into a hard and black surface. The eastern edge was strengthened with both clay and bivalve shells. To the west of the entrance laid the firebox within which thin layers of light-red sand and dark gray plant ash were sandwiched. The sand layers were covered over a large extent with a grayish-white or grayish-green hard surface. At least 15 brittle, fragmented red-brown helmet-shaped pottery vessels were found, mostly planted within the sand, surrounded by grass tempered mud and there were holes into which helmet-shaped pottery vessels were placed. On the west side of the firebox a narrow wall was built of clay which reinforced the entire back of the furnace. In the middle

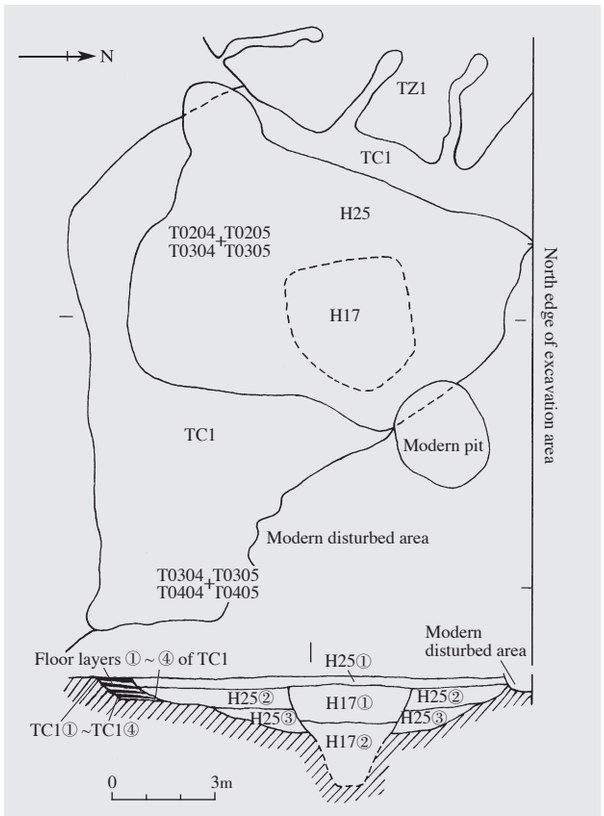

Figure 3 The plan and section of brine pits H17, H25 and salt-drying floor TC1.

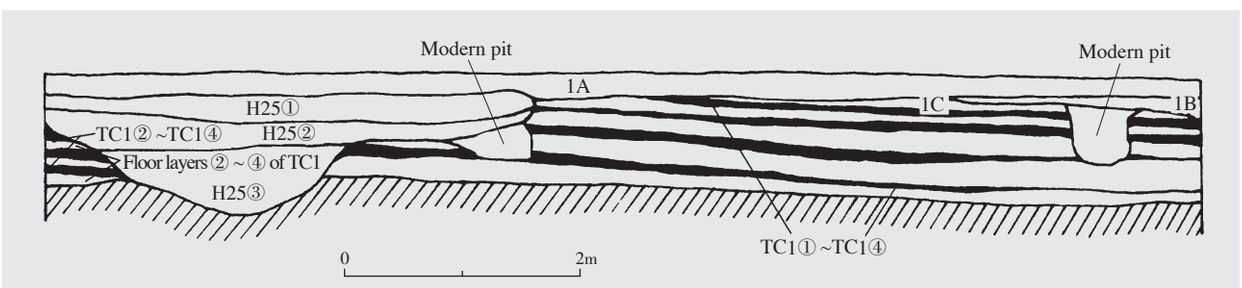

Figure 4 The north wall of excavation grid T0304.

of the firebox, two rectangular pillars were found, which formed three narrow fire channels with the two side walls. The west end of the firebox was linked with two circular flues for smoke to escape. The northern flue (A) was constructed using at least 20 broken helmet-shaped pottery vessels. The southern flue (B) was made out of various chunks of clay (Figures 5–10).

Furnace YZ3 located about 10m to the north of YZ4 was roughly in a circular plan and nearly 50cm thick. The feature can be divided into four strata, each of

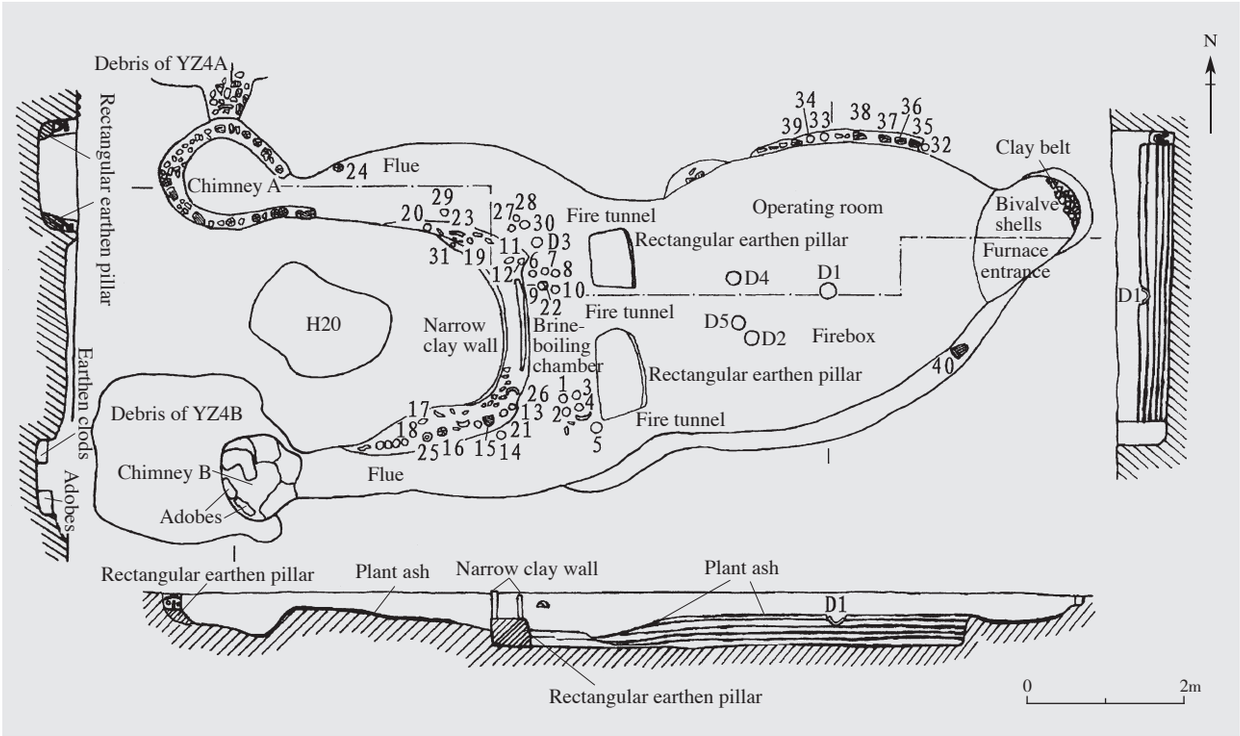

Figure 5 The plan and sections of salt furnace YZ4.
1–40. helmet-shaped pottery vessels D1–D5. postholes

Figure 6 YZ4 (S–N).

Figure 7 The western part of the first layer of YZ4 (E–W).

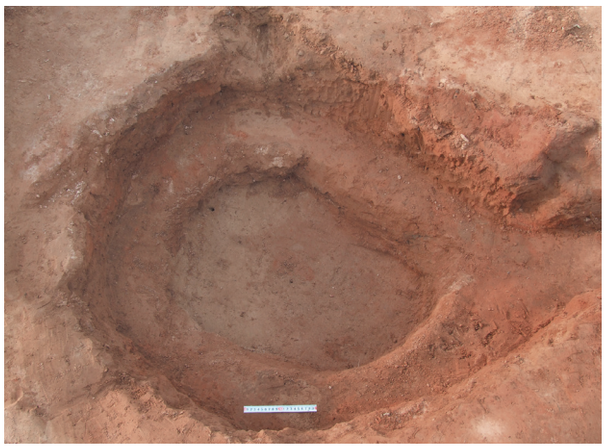

Figure 9 Chimney A of YZ4 after recovering (S–N).

Figure 8 Chimney A of YZ4 (S–N).

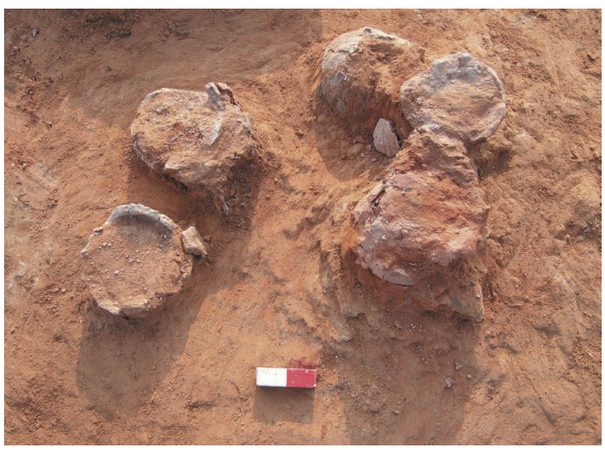

Figure 10 The helmet-shaped pottery vessels found from YZ4 *in situ* (E–W).

which covered approximately 2 to 7sq m. The size of this feature is rather small. The middle of each stratum consisted of an area of dark red clay made up of a certain number of small burnt areas on top of which lain several rather large sandy helmet-shaped pottery vessels. The clay area is surrounded by reinforcement constructed of light red sand and broken helmet-shaped pottery vessels (Figure 11).

Furnace YZ1 lay between YZ3 and YZ4 in the area of a large pile of fragmented helmet-shaped pottery vessels. This area covered a 200sq m area and was 1m thick, which was composed of large number of fragments of helmet-shaped pottery vessels, red-burnt earth and small amount of fine sand. The fragments of helmet-shaped pottery vessels of different sizes were distributed densely. Also, a certain number of strips composed of clay adobes were found together, each strip was composed of three or four adobes that were red or red-brown in color and were plastered with silt or sand on the outside (Figures 12 and 13).

4. Houses: five of them (F1-5) were recovered, most of which were poorly preserved. Feature F3 was a semi-

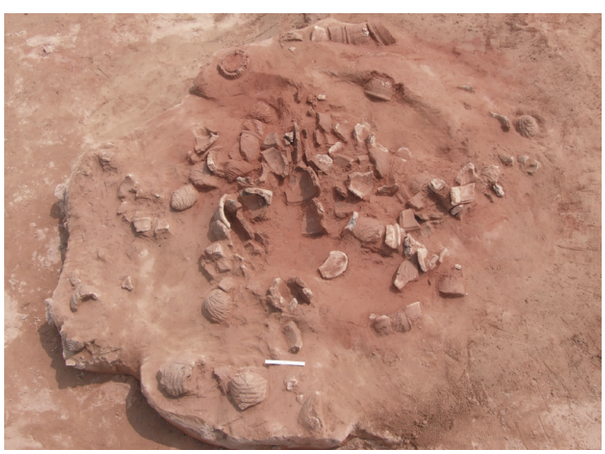

Figure 11 The second layer of YZ3 (W–E).

subterranean foundation situated between TC1 and YZ4 and partly preserved to about 0.4m deep and could be separated into three strata. Stratum 1 was rectangular in plan with curved corners, 7.5m long, 5m wide,

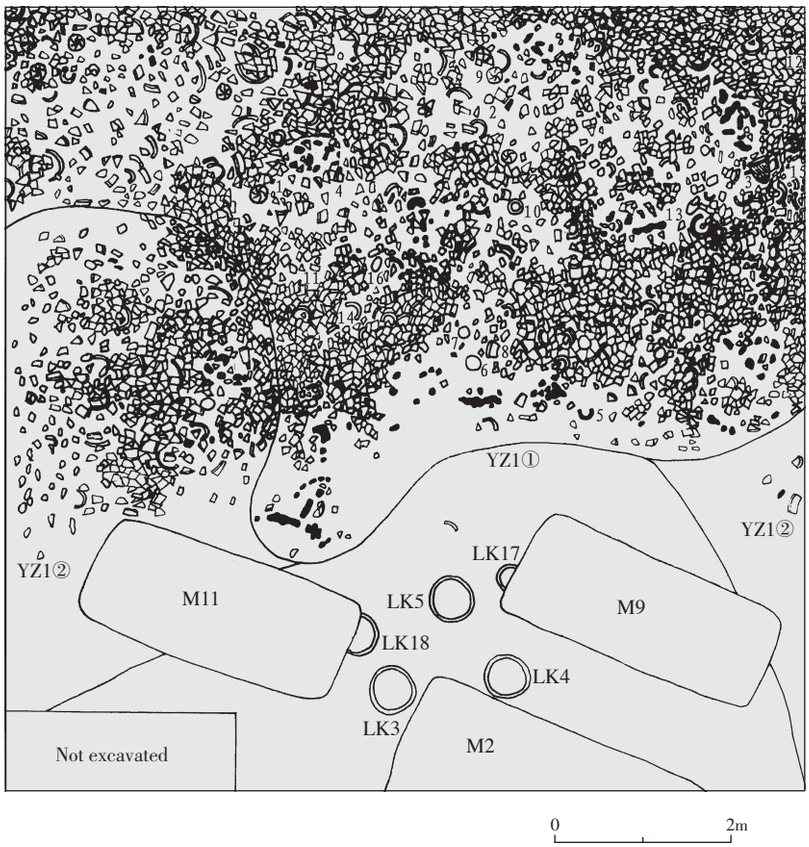

Figure 12 Salt furnace T0105YZ1 and the distribution of pits for filtering or storing brine LK3, LK4, LK5, LK17 and LK18 (the dark pieces are clay adobes).
1–16. The first layer of the helmet-shaped pottery vessels of YZ1

Figure 13 The western part of the first and second layers of YZ1 (S–N).

covering an area of 38sq m. A total of 10 circular postholes arranged in a Y-shape were found in the central area of the foundation. Strata 2 and 3 were somewhat smaller on the southern portion and covered areas of 22 and 16sq m respectively. They had eight and four identifiable postholes, both of which seemed irregularly organized. The construction of F3 seemed to have been rather simple, and no remains of walls have been found. It is believed to represent a simple shelter (Figure 14).

5. Pits for filtering or storing brine: 18 of them (LK 1–18) were recovered. They were mostly found in the vicinity of the salt furnaces. They were usually in circular plan with diameters less than 0.5m, although a few had diameters over 1m (Figure 15). A thick layer of fine clay was plastered on the walls of the pits in order to ensure that water did not seep out during their use. Pits LK9 and LK11 (the latter of which was intruded into by the former) were both with circular plan and flat bottoms and diameters of 0.6 and 1.44m, respectively, and about 0.36m deep. A few fragments of helmet-shaped pottery vessels and shellfish were recovered from these pits (Figure 16).

6. Ash pits: 20 of them were recovered. Most of these were associated with the daily-life activities of the local population, although a few might have been connected to the salt-making activities. H20 was in a nearly circular plan and with a relatively flat base, a maximum diameter of 2.8m, and a depth of 0.45m. This pit was located between the two flues of furnace YZ4, and was crammed full with a grayish-white or grayish-green mixture of lime and sediment. It was probably used for storing lime being added to the brine within helmet-shaped pottery vessels during the process of salt-making in the furnace YZ4 (Figure 5).

Artifacts

Around 800 artifacts of the Western Zhou Dynasty have been recovered in the excavations including many potteries, some seashells, and a few

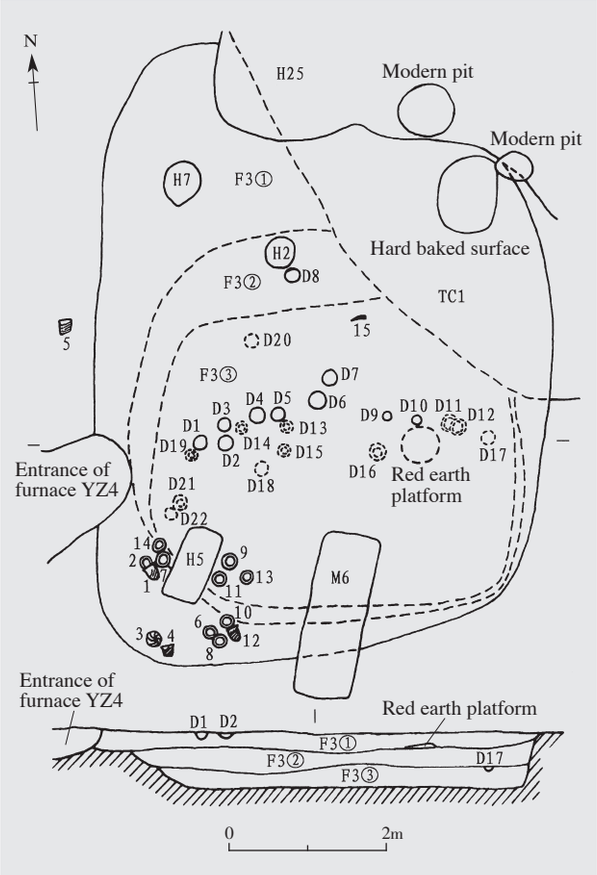

Figure 14 The plan and Section of house Foundation F3.
1–14. the first layer of helmet-shaped pottery vessels 15. the first layer of bone knives D1–D10. the first layer of postholes D11–D16, D19 and D20. the second layer of postholes D17, D18, D21 and D22. the third layer of postholes

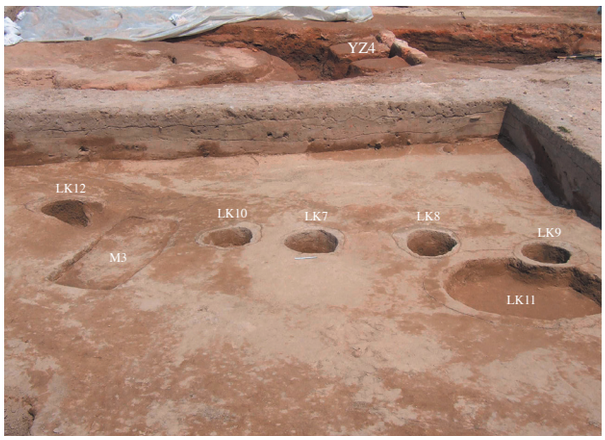

Figure 15 Brine pits LK7–LK12 (S–N).

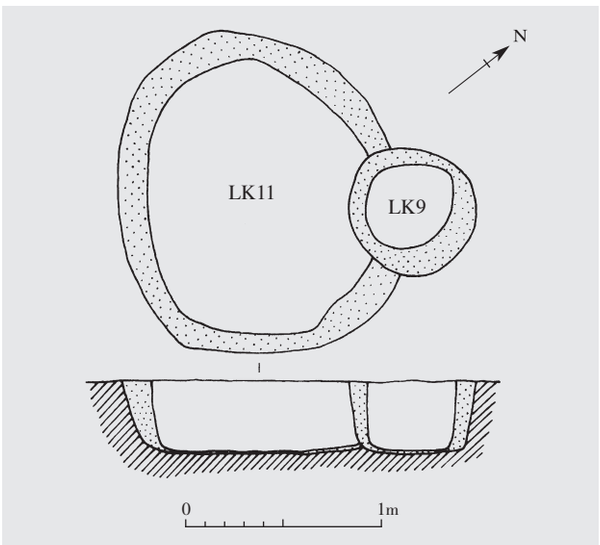

Figure 16 The plan and section of LK9 and LK11.

animal bones. The potteries are mostly helmet-shaped pottery vessels, jars, *li*-cauldrons, basins, *gui*-tureens, *yan*-steamers, and *dou*-stemmed bowls.

Helmet-shaped Pottery Vessels: A total of 500 complete or typical specimens were recovered in addition to innumerable fragments. Many of the specimens have a hard white layer of precipitate on the interior surface. Some examples have become red or reddish brown on the exterior surface near the base due to placement over fires. These vessels were constructed by coiling strips of clay and then wiping the exterior and interior with the hands. The rim area was finished on a turnette and the vessel exterior was decorated with cord pattern. Most of these vessels have slightly flaring mouth and bent rim, a convex body and round bottom. A small number had curling lip, sloping belly and pointed bottom. The rim diameters for most examples were between 17 and 20cm, and they were 20 to 22cm tall, with walls 1.5 to 2cm thick. The shapes of these vessels were quite standardized, but they were coarse and heavy.

Helmet-shaped pottery vessels can be classified into four types. Type I have lips that are pointed or pointed and round on the outside without a clear shape on the inside or groove on the top. They have sloping bellies and pointed bottoms. Most cases have bottom lost. Examples include: H17 ① :1, which is gray sandy ware (Figure 17:6); H25 ① :3, also gray sandy ware (Figure 17:5) and YZ4 ⑦ :1, which is red sandy ware (Figure 17:1).

Type II Helmet-shaped pottery vessels have lips that are round-pointed or rounded on the outside and rounded on the inside while their tops have clear grooves. These vessels have sloping walls and pointed bases. Examples include YZ3 ③ :01, which is a gray fine ware vessel with a mouth diameter of 21.9cm and height of 24.7cm (Figures 17:8 and 18); and YZ3 ② :25, a gray sandy ware with a partly-damaged base and a mouth diameter of 20cm (Figure 17:9).

Type III helmet-shaped pottery vessels have lips with

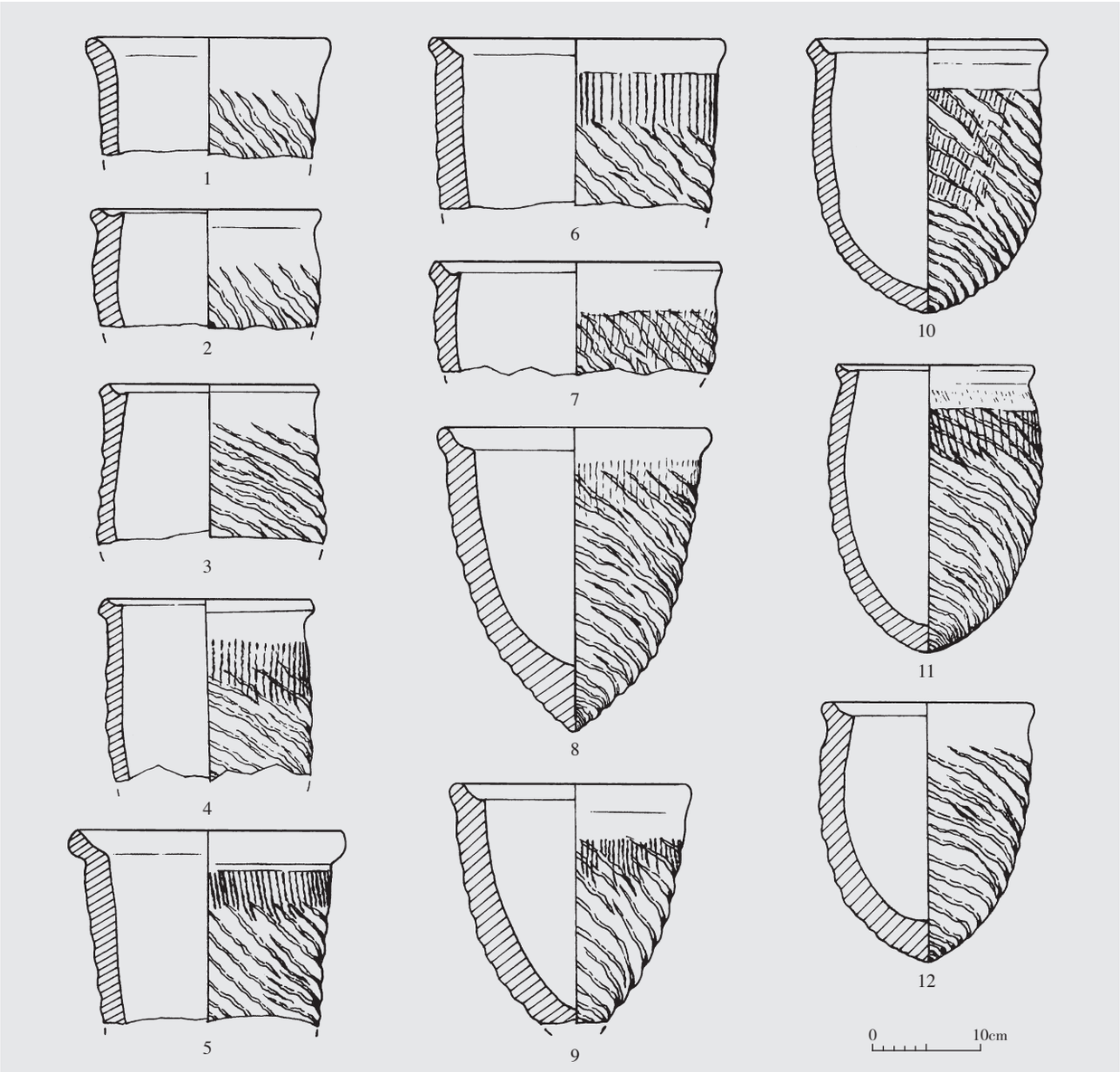

Figure 17 Helmet-shaped pottery vessels unearthed from Nanheya Site.
1, 5 and 6. Type I (YZ4 ⑦ :1, H25 ① :3 and H17 ① :1) 2, 7, 11 and 12. Type III (T0104 ② :1, T0106YZ ② :3, T0105YZ ① :03 and H11:1) 3, 4 and 10. Type IV (T0304TC ① :2, LK9:1 and F3 ① :3) 8 and 9. Type II (YZ3 ③ :01 and YZ3 ② :25)

rounded or rectangular exteriors, rounded interiors, and grooves. They have convex bodies and rounded bottoms. Examples include: T0106YZ1 ② :3, a gray fine ware vessel that only has a preserved upper portion but seems to be shaped like a shallow basin (Figure 17:7); T0105YZ1 ① :03, also a gray fine ware with a mouth diameter of 18.4cm and height of 21.6cm (Figures 17:11, 19); H11:1, a gray fine-ware vessel 16.9cm wide at the mouth and 24.3cm tall (Figure 17:12); and T0104 ② :1, a brown sandy vessel only partially preserved and, like the first example, with an upper portion shaped like a shallow basin (Figure 17:2).

Type IV helmet-shaped pottery vessels have lips that are rectangular on the exterior, pointed on the inside and have clear grooves. The vessel bodies are convex or droopy and they have rounded bases. Examples include: T0304TC1 ① :2, a gray sandy vessel, only the upper portion of which is preserved (Figure 17:3); LK9:1, a similarly partial gray fine ware vessel (Figure 17:4); F3 ① :3, a gray fine ware vessel that is 18.3cm wide at the mouth and 21.7cm tall (Figure 17:10); T0205YZ1 ② :05, a brown fine ware vessel, which has red burnt clay chunks

Figure 18 Helmet-shaped pottery vessel of Type I (YZ3③:01).

Figure 20 Helmet-shaped pottery vessel of Type IV (T0205YZ1 ② :05).

Figure 19 Helmet-shaped pottery vessel of Type III (T0105YZ1 ① :03).

attached to its bottom portion and is 18.2cm wide at the mouth and 22.5cm tall (Figure 20).

Jars: Approximately 100 examples were recovered and these can be divided into two types. The vessels of type A have squared lips, relatively wide flaring rims, concave bodies and flat bottoms. The bodies of these vessels are decorated with thick cord marking or bowstring pattern. An example is H17 ① :49, a gray fine ware vessel with a fragmentary base, a mouth diameter of 16.8cm, and surface decoration that includes bowstring pattern on the upper part of the body and two belts of cord marking on the lower body (Figure 21:3). Type B vessels have pointed lips and folded rims, convex bodies and flat bottoms. The upper part of the body is decorated with incised lines. Examples include: T0103 ③ :3, a black fine ware vessels with a mouth diameter of 13.6cm (Figure 21:10); and H17 ① :03, a black polished fine ware vessels with a mouth diameter of 10.6cm and a height of 13.2cm (Figure 21:11).

Li-cauldrons: More than 40 examples are known which can be divided into four types. Type A *li* have square lips, and relatively wide folded rims. Most of the rims have incised grooves, the crotch is usually rather flat, and there is coarse cord marking on the body. An example is H25 ① :1, which is a black sandy ware vessel with fragmentary pouch-shaped feet and a mouth diameter of 32cm (Figure 21:4). The vessels of Type B have pointed rectangular lips and folded rims, and relatively high-arch to the crotch between feet, and bodies with rather fine cord-marking. An example is T0404TC1 ① :1, which is gray sandy ware with a fragmented crotch, a mouth diameter of 20.8cm and a height of 19.7cm (Figure 21:2). Type C is imitation of the bronze *li* in that they have pointed rectangular lips and wide, folded rims, necks, relatively low crotches and fine cord marking on their bodies. The upper body has three cockscomb-shaped lugs. An example is F1:02, which is a gray sandy ware object that is 16.5cm wide at the mouth and 14.1cm tall (Figure 21:12). Type D vessels have shell temper, pointed rectangular lips, folded narrow rims, breast-shaped pouch feet, a tall crotch area, and plain surface. Examples include: F1:3, which has pouch-shaped feet and is brown shell-tempered ware that is 21.4cm in the mouth diameter (Figure 21:1); and F3 ② :1, a gray shell-tempered specimen with fragmentary pouch-shaped feet that have

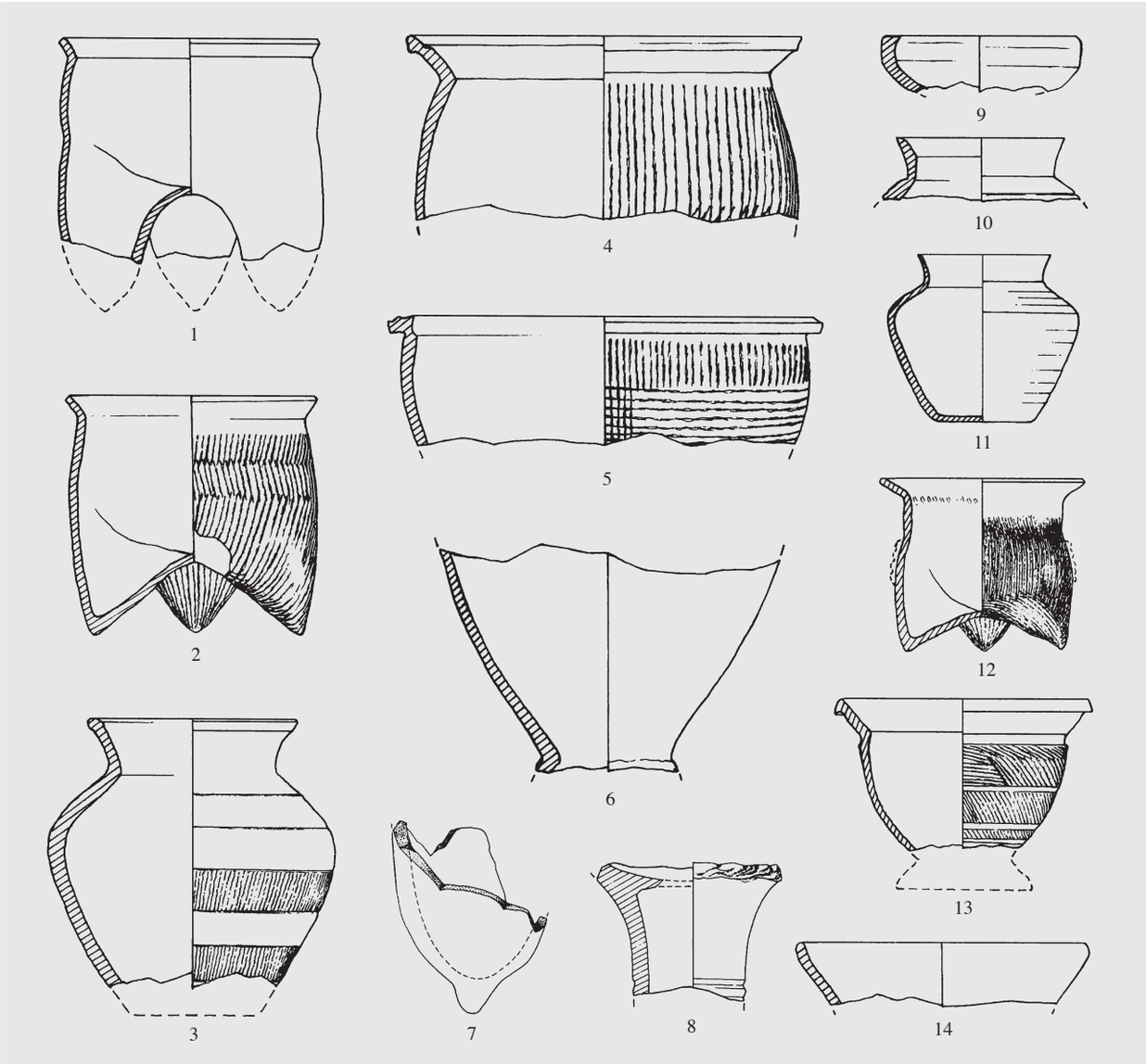

Figure 21 Potteries unearthed from Nanheya Site.
1 and 7. *li*-cauldrons of Type D (F1:3 and F3 ② :1) 2. *li*-cauldron of Type B (T0404TC1 ① :1) 3. jar of Type A (H17 ① :49) 4. *li*-cauldron of Type A (H25 ① :1) 5. basin (H17 ① :40) 6. *yan*-steamer (F1:1) 8 and 9. *dou*-stemmed bowls (T0105 ③ :010 and F3 ② :2) 10 and 11. jars of Type B (T0103 ③ :3 and H17 ① :03) 12. *li*-cauldron of Type C (F1:02) 13. *gui*-tureen of Type A (H25 ② :3) 14. *gui*-tureen of Type B (H11:2)

rather long solid portions (Figure 21:7).

Gui-tureens: Twenty examples are known and can be divided into two types. Type A vessels have thick, square lips and slanted, concave bodies with short ring-feet attached to the base. The vessel bodies are decorated with triangular incisions filled with fine cord marking or, in some cases, smeared cord marking. Examples include H25 ② :3, which has a fragmentary ring foot, a mouth diameter of 21cm, and is made of gray fine ware (Figure 21:13). Type B vessels have rounded lips, thick folded rims, and relatively deep bodies with concave sides. The ring feet are rather tall and they lack surface decoration. An example is H11:2, which is a fragment of a vessel mouth composed of black fine ware with a diameter of 23.7cm (Figure 21:14).

Basins: Ten examples are known. They have thick square lips and bent rims, curved, inclined walls and flat bottoms, and the bellies were decorated with thick cord patterns. Sample H17 ① :40 is a lower section of the body and a base made of gray fine-ware with a rim diameter of 32cm (Figure 21:5).

Yan-steamers: The ten examples are all fragmentary.

The steamer portions have pointed rounded rims, narrow bent lips, shallow drum-shaped bodies with a narrow waist, and no surface treatment. Specimen F1:1 has fragmentary mouth and tripod portions, is made of red-brown sandy-ware, and has a single set of appliqué on the waist. The remaining height is 18.5cm (Figure 21:6).

Dou-stemmed bowl: There are five fragmentary examples. F3 ② :2 is a *dou* bowl made of gray fine-ware, has a flat lip that projects slightly inward, and a straight rimmed shallow belly. The rim diameter is 16cm (Figure 21:9). Sample T0105 ③ :010 is a relatively tall *dou* stem made of gray fine-ware with bamboo joint-shaped nodes (Figure 21:8).

Summary

1. The Date of the Site: Although few pottery artifacts have been discovered at the site, their time characteristics are relatively clear. B-type *li*-cauldron with the high-arch crotches are representative Zhou-style *li*, and based on the height of the crotch these should date around the Middle Western Zhou. The C-type *li* imitating bronze ones were also representative Zhou Dynasty artifacts with crotch characteristics that date to around the Middle Western Zhou. These potteries are quite common in Early to Middle Western Zhou contexts in inland northern Shandong such as the sites of Caoqiao and Wucun in the south of Guangrao County. The remains here, therefore, likely dated to the Middle Western Zhou Dynasty.

2. Site type: The structure of feature YZ4 and the characteristics of its associated debris are similar to those of a pottery kiln, but the helmet-shaped pottery vessels unearthed from it were all intact ones without fragmentary remains. The inner surfaces of these helmet-shaped pottery vessels were all covered with a layer of white residues. A kiln seldom produced these types of remains, and furthermore the size of this feature was much larger than other known pottery kilns of the same period. YZ4, therefore, was not used as a pottery kiln. Based on previous work done at the Western Zhou salt-making remains at Dahuangbeiyang Site in Shouguang City (7km north of the Naheya Site), the white residues on helmet-shaped pottery vessels would likely be left behind by the process of boiling salt out of solution. Furthermore, the density of helmet-shaped pottery vessels and other aspects of the excavation results were similar between the two sites. For these reasons we can conclude that feature YZ4 was a furnace used for the salt-making by boiling and that the Nanheya Site was a salt-making workshop during the Western Zhou Dynasty rather than an agricultural location or a residential site.

3. Brine boiling process: Based on a preliminary analysis of the remains, we can figure out a relatively complete workflow of the salt-making technique at Nanheya. They first would dig a pit to collect underground salt-water, and then from that pit they would scoop the briny water out and sprinkle it across a flat surface. There the salt-water would undergo chemical reaction in contact with plant ash, replacing the soluble salts within the plant matter and causing salt crystals to form on the surface of the plant ash particles. These salt crystals were then scraped together and put into brine filtering pits where they would dissolve and settle, creating brine with a much higher concentration of salt. At this point, the brine was placed into helmet-shaped pottery vessels, which were put on a furnace used to evaporate the water – directly resulting in the crystallization of salt. Finally, the helmet-shaped pottery vessels were broken to remove the block of salt. This site provides valuable information for investigating the origins and development of early salt-making techniques in China and therefore has extremely significant academic importance.

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Postscript

The original report published in *Kaogu* (Archaeology) 2010. 3: 37–49 with 15 illustrations and 11 plates, was authored by Wang Qing 王青, Rong Zilu 荣子禄, Zhao Jin 赵金, and Wang Liangzhi 王良智. This version was edited by Wang Qing and translated into English by Rowan Flad 傅罗文.