

2000–01 Excavation of the Shang Bronze Foundry Site at Xiaomintun Southeast in Anyang

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In the springs of 2000 and 2001, excavation was carried out at Xiaomintun 孝民屯 Southeast Locus, about 5 kilometers northwest of modern city Anyang 安阳 (Figure 1); the excavation covered an area of about 5,000 square meters. Among the most important findings is a large area of bronze foundry remains as briefly discussed in this report.

Foundry Features

A number of excavated features are found to be most likely associated with bronze casting; they include trash pits (or storage pits), building foundations, and a working surface related to the polishing and finishing of cast bronzes.

Among casting-related trash pits is 2001AGH27 dated to Yinxu 殷墟 Phase III. This pit has an oval-shaped opening, slanted wall and rounded base, measuring 10.25m long, 6.4m wide, and 2.9m deep. The pit is filled with loose gray-color soil. Near the northwest corner of the pit is a pile of crucible fragments, probably resulting from a single deposition after the discard of a melting crucible. At the northeast corner of the pit is found a cattle skeleton, partially destroyed by later features, which might be associated to a performed casting ritual.

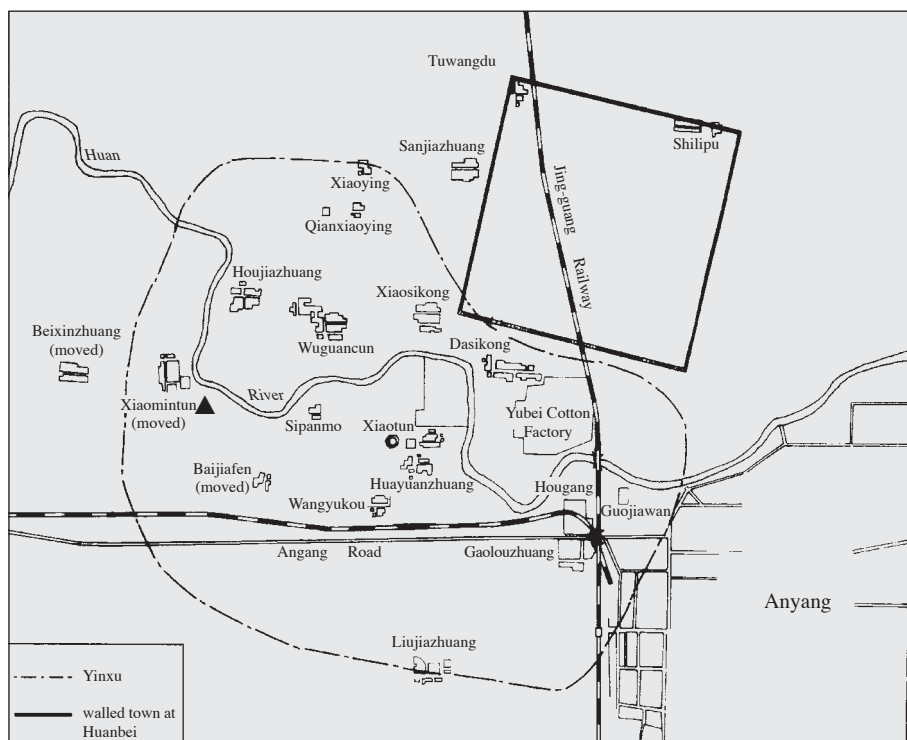


Figure 1. Map showing the location of the bronze foundry site at Xiaomintun Southeast in Anyang

The fill deposit of the pit contains abundant broken ceramic vessels and crucible fragments, many pieces of red burnt earth, copper residue, charcoal, and animal bone, and a few clay mold fragments.

Thirteen building foundations of the Yin period were excavated. One of them is 2001AGF6, dated to Yinxu Phase III, only the bottom part of which is preserved. It is over 16.5m long east-west (part of it is outside the excavation square) and about 10m wide north-south. Cutting into two earlier trash pits and a tomb, F6 is superimposed by later buildings F5 and F7, trash pits and

tombs. In the middle of the building is a partially preserved kiln (furnace) measuring about 1.8m long, 0.4m wide and 0.5m high. The side wall of the kiln is burnt red; stairs are found on the west side. The bottom of the kiln is covered with a thick layer of white ash. The kiln was likely used for baking clay molds. About 3m north of the kiln is a pile of broken crucibles. In addition, a few pieces of unused finely carved molds are found on the activity surface of F6. All these suggest that F6 was constructed for forming and baking clay molds as well as melting the metal (Figure 2).

A working surface covered with a thin layer of bronze residue (corrosion-like materials) is found in the northern part of F5. The surface is largely destroyed by modern house structures, and only one square meter is preserved. This bronze residue-covered surface is likely formed from the retouching and polishing of cast bronzes – the last step of the production of cast bronzes.

Foundry Remains

The excavation at Xiaomintun Southeast yielded a considerable quantity of versatile bronze foundry remains. In terms of their function and use, their remains can be classified into categories of melting, casting, retouching/finishing, and other uses.

Melting Vessels

The crucibles are the only remains of metal melting. There are two types of crucibles: straw-tempered and sand-tempered.

The straw-tempered crucible is often called “melting furnace 熔炉” in Chinese. About three thousand pieces of straw-tempered crucibles are found. The inside surface of these crucibles contains no or little trace of molten copper, suggesting that they are fragments of over-used crucibles. These crucibles, constructed of straw-tempered clay, are composed of four different layers: inner lining, interior body, straw-tempered shell, and outer reinforcement. Some pieces show multiple inner linings, indicating that the crucible might have been repeatedly used and repaired. On the interior lining of a few crucible fragments are traces of charcoal and copper residue, and they suggest that chunks of charcoal were inserted inside the crucible for heating and melting copper. These crucibles vary in size, and the middle-sized crucibles, 50–100cm in diameter, are dominant among the unearthed. Most of these crucibles were con-

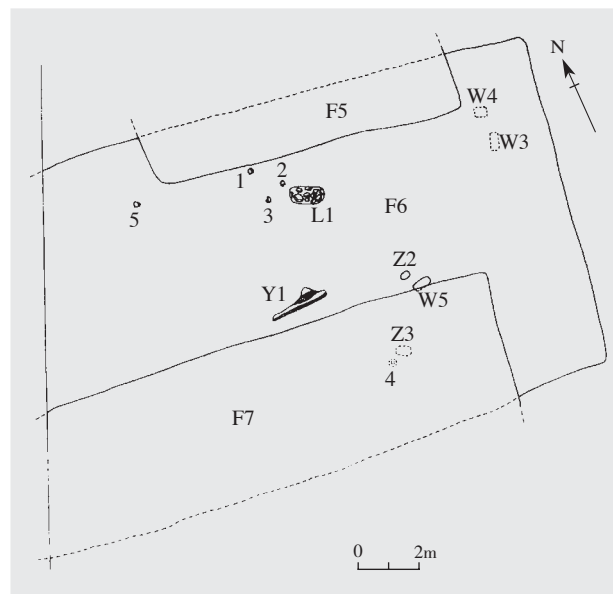


Figure 2. House remain of 2002AGF6
1–3. ceramic molds 4. post hole 5. plinth stone

structed through the coiling of clay strips; some by the slabbing method. An example of the crucibles constructed through the coiling of straw-tempered clay is 2000AGT14 ③:22 whose inner lining, green gray in color and slightly shining, is partially vitrified. The interior body of the specimen, with dark gray coloration, is constructed of coiled strips of straw-tempered clay. The outer layer is also dark gray, and composed of straw clay mixture. The curvature of the specimen measures 17.5cm, with a thickness of 3.5cm and an estimated diameter of 60cm (Figure 3).

The sand-tempered crucible refers to the narrowly-defined “crucible 坩埚” in Chinese. Only about 100 pieces were found from the excavation at Xiaomintun Southeast. The inner surface often contains traces of molten copper. The crucible body is heavily tempered with coarse sand; its thickness is over 1cm. The crucible inside is rounded or oval-shaped, about 35cm in diameter. The inner surfaces in contact with molten copper are gray green in color, and porous. The outer surfaces of the crucibles are red-colored. Such crucibles were also heated from the inside. The specimen 2000AGH23:4 is an example of sand-tempered crucibles. It has five layers of linings; the three innermost ones contain traces of bronze residue. It is about 2cm in thickness, and 4.9cm in curvature with an estimated diameter of 30cm (Figure 4).

Straw-tempered crucibles are usually larger than sand-tempered ones. The former might have been placed above the ground, and it had an outlet and even a cast-



Figure 3. Crucible (2000AGT14③:22) constructed of straw-tempered clay

ing channel in some instances, for releasing the molten metal. This type of crucible was likely used for manufacturing large-size bronzes. The sand-tempered crucible had no outlet; casting might involve the ladling of molten metal into the assembled molds, mostly for casting small-sized objects.

Casting Paraphernalia

The remains of bronze casting at Xiaomintun Southeast include models, molds, and cores, all made of baked clay.

Models

Less than 100 model fragments are found, including complete 全模 (one-piece) and composite models 组合模, both constructed of untempered clay. Most of them are for vessel appendages such as animal heads, handles, flanges, post caps, etc. The specimen 2000AGT10③:3, green gray in color, is a mushroom-shaped boss model, 5.3cm high and 5.5cm in diameter, possibly for stamping spiral patterns onto the molds. The spirals were constructed by adding clay strings on the top surface of the model, judging from the partial peeling. The bottom section is a handle-like stem for better gripping (Figures 5:1; 6). Another model with a similar handle-like stem is 2000AGT15 扰坑:1 that is embossed with a cattle head. This specimen, only slightly broken, is low fired to red coloration inside the body, but the outer surface is dark gray. It measures 5.2cm high and 5.2cm wide (Figure 7). Their two clay models are sole examples of decoration stamps found at Anyang.

Molds

Most bronze casting remains are clay molds; over



Figure 4. Crucible (2001AGH23:4) constructed of sand-tempered clay

30,000 mold fragments are unearthed, mostly for casting ritual vessels. The identifiable vessel types represented by these molds include *ding* 鼎 tripod, *yan* 甗 steamer, *gui* 簋 tureen, *pou* 甬 vessel, *yi* 匱 ewer, *lei* 鬯 vessel, *you* 卣 vessel, *zun* 尊 vessel, *gu* 觚 vessel, *jue* 爵 tripod, *jia* 斝 tripod, *zhi* 觶 vessel, *gong* 觥 vessel, *he* 盃 vessel, *pan* 盘 plate, *dou* 豆 stemmed dish, lid, stand, etc; the most common types are *gu*, *ding*, and *you*, and they are followed by *gui*, *lei*, and lid. The dominant décor motifs engraved on mold sections are animal-face and dragon designs, and *yunleiwen* 云雷纹 (cloud-spiral patterns) often forms the ground decoration.

The excavated molds can be roughly divided into two groups: first, the outer molds with an uneven exterior surface on which fingerprints are common; second, the outer molds with a smooth surface on which are often some narrow ridges. The former molds are typically thick; some of them made of two distinctive layers: an inner layer of fine clay and an outer one of coarser clay. The latter molds are relatively thin, and composed of only a single layer of clay; they were usually used to cast small-sized vessels, especially *gu* and *jue*.

Molds are joined with mortises and tenons. Mortises are in various shapes such as triangle, rectangle, trapezoid, circle, and irregular; they are cut into the sides of mold sections. Tenons were constructed through either building up a small piece of clay onto the mold or carving the body of the mold directly. Some joining sides of the mold sections are coated with reddish fine clay slip as adhesive.

The interior surfaces on contact with the molten metal often have patches of soot, indicating that soot was prob-

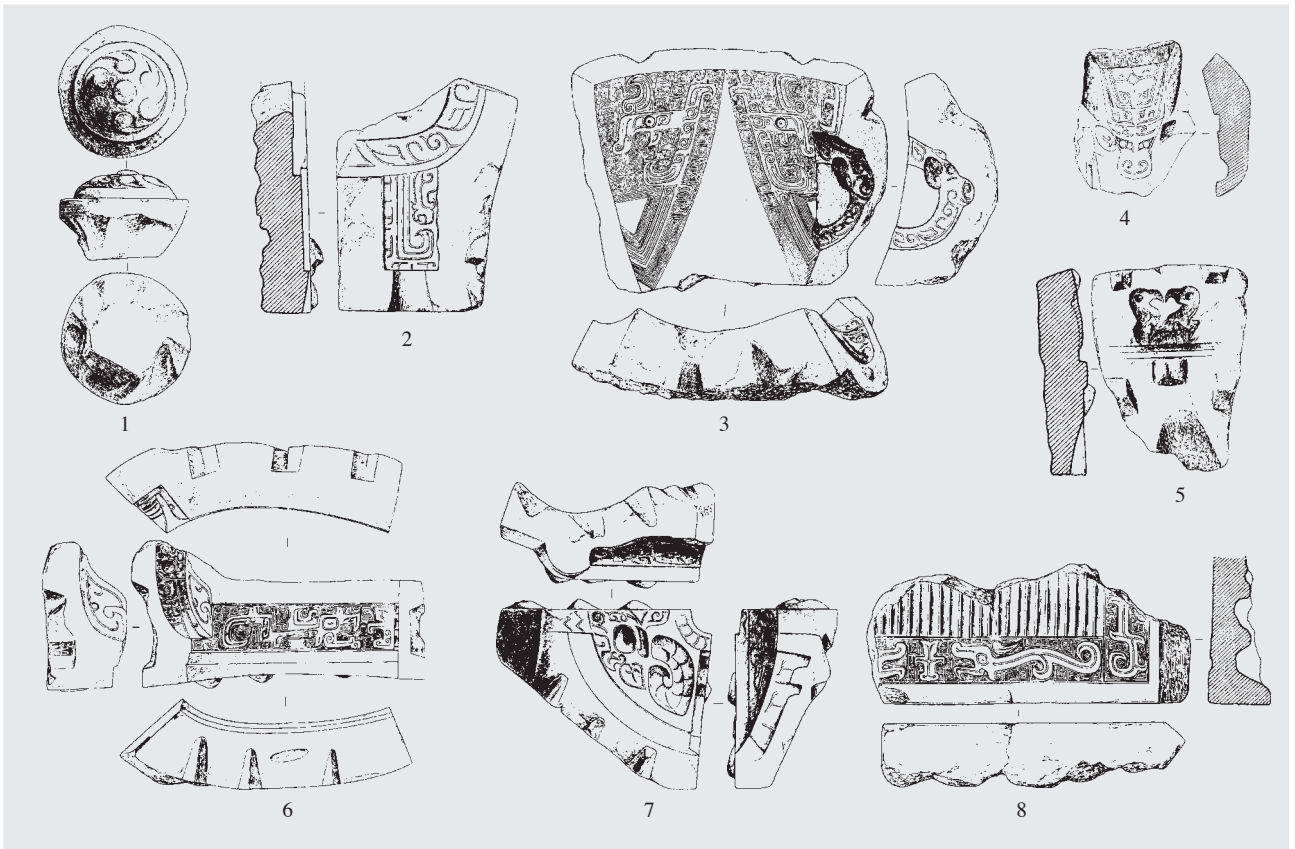


Figure 5. Molds

1. boss model (2000AGT10③:3) 2. mold for gui handle (2000AGH31:12) 3. mold for lei vessel (2001AGH28:4) 4. cattle head (2001AGH28:8) 5. bird head (2000AG14③:7) 6. lid of you vessel (2000AGT14扩②:1) 7. vessel lid (2001AGH25:3) 8. vessel stand (2000AGH31:6)



Figure 6. Boss Model (2000AGT10③:3) probably used as a decoration stamp



Figure 7. Cattle Head Model (2000AGT15扰坑:1) probably used as a decoration stamp

ably added for easily removing the mold sections from the metal after casting.

Only a few selected mold sections are briefly illustrated here.

Mold for *gui* handle (2000AGH31:12): 16.2cm high, 10–12cm wide, 4.4cm thick. The interior surface color is green gray; the exterior surface is light red. On the right side of the mold section is a tenon; under the end of the handle pendant is a pouring inlet (Figure 5:2).

Mold for *lei* vessel (2001AGH28:4): 15.4cm high and 4.8cm thick. This mold is for casting the lower portion of a *lei* vessel. The inner layer of the mold is fine clay and green gray in color while the outer layer, made of

sandy clay, shows light reddish coloration. Two mortises are present on the upper side of the mold; two tenons are placed on the lower side. Two additional tenons might have come off the left side of the mold. In the middle right portion is a handle that is decorated with a cattle head. The décor motif of the interior surface consists of a large banana leaf shape surrounded by triangular and dragon designs; *leiwen* is incised on the ground (Figures 5:3; 8).

Mold for the lid of *you* vessel (2000AGT14⁺②:1): 5.6–8.4cm high, 4.4cm thick. It shows light gray coloration with some light red patches on the outer surface. Three mortises were found on the upper side of the mold,



Figure 8. Mold for *lei* vessel (2001AGH28:4)



Figure 10. Mold for fish (2001AGH2:1)



Figure 9. Mold for vessel lid (2001AGH25:3)



Figure 11. Rubbing of the inscriptions on core (2001AGH2:20)

and four tenons on the lower side. The interior surface is decorated with banded bird designs; the ground is filled with *yunleiwēn*. The protruding appendage on the left is decorated with cicada-shaped pattern. The interior surface of the mold shows traces of red fine slip. This mold section has a height of 5.6–8.4cm and a thickness of 4.4cm (Figure 5:6).

Mold for vessel lid (2001AGH25:3): 4.8cm thick. It is an oval-shaped mold section; both inner and outer layers are constructed of clay material containing traces of fine sand. It has green gray coloration. There is a hole in the center. Three tenons are found on both the inner arc surface and the right side of the mold; two additional

tenons on the left side. The interior surface is covered with animal-face patterns, but no decoration is applied on the ground (Figures 5:7; 9).

Mold for rectangular vessel stand (2000AGH31:6): 8.5cm high, 18cm wide, 4.2cm thick. It is a broken mold section for casting a vessel stand. Neither mortise nor tenons is found. In the middle portion of the inner surface is a pattern of vertical ribbing surrounded by a *leiwēn*-grounded band with a pair of horizontal head-to-head dragons on the bottom and a vertical S-shaped dragon on the left (Figure 5:8).

Mold for cattle head (2001AGH28:8): 10cm high, 4.2–8.4cm wide, and a 2.6cm thick. It is a slightly bro-



Figure 12. Molds

1. fish (2001AGH2:1) 2. numbering characters (2000AGT14 ④:1) 3. core with inscriptions (2001AGH2:2)

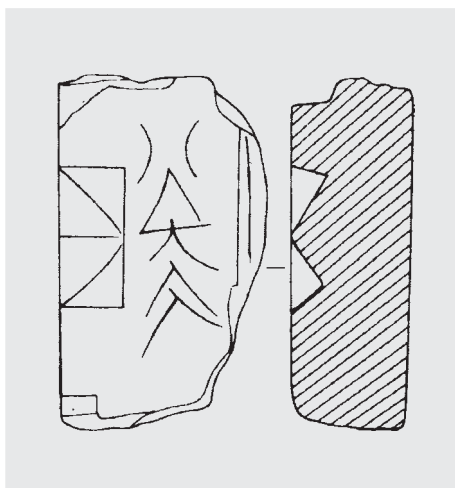


Figure 13. Mold for numbering characters (2000AGT14 ④:1)

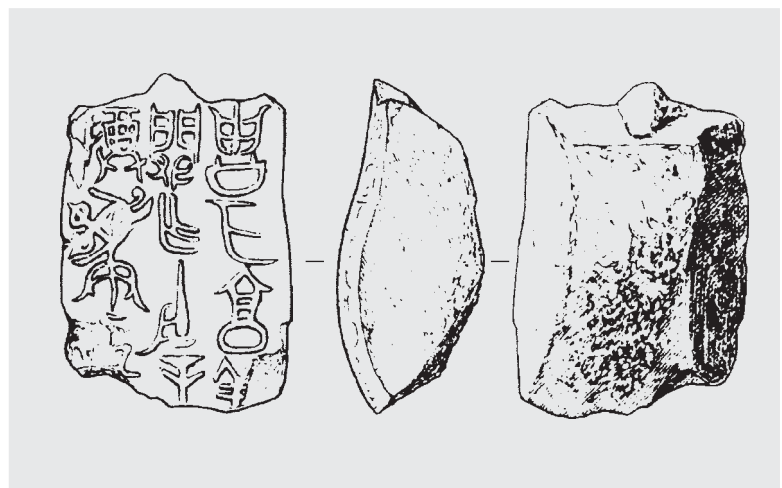


Figure 14. Core with inscriptions (2001AGH2:2)

ken mold section for a dimensional cattle head appendage on the handle of a *you* vessel. It is green gray in color, and the outer surface is slightly red. Two tenons are seen on the bottom side (Figure 5:4).

Mold for bird head (2000AG14 ③:7): 10.9cm high, 8.1cm wide, and 2.4cm thick. This clay mold is for casting a bird head appendage. Four tenons are placed on the corners of the interior surface; one in the middle. There is also a horizontal groove which might be used to wedge the appendage onto the master mold. A pair of beak-to-beak birds are carved into the mold section (Figure 5:5).

Mold for fish (2001AGH2:1): 5.8cm high, 3.4cm wide, and 1.4–2.1cm thick. It is a mold section for casting a fish appendage. The mold section has very dark gray coloration; the outer surface is smooth, containing a groove. The interior surface is decorated with a lively fish whose head points to a pouring inlet (Figures 10; 12:1).

Mold for numbering characters (2000AGT14④:1): 7.2cm high, 4.1cm wide, and 2.3cm thick. The mold section is constructed of fine clay; it is dark gray, smooth on its outer surface. Two mortises are placed on the left side of the interior surface; one mortise on the bottom side. Divinatory inscriptions “八六一六六六” are deeply incised on the interior surface (Figures 12:2; 13;).

Cores

About 100 clay core fragments are identified. Cores were often called inner molds in early Anyang excavation reports. Most cores are composed of low fired clay and sandy clay; they are relatively friable and poorly preserved. They are often indistinguishable with chunks of red burnt earth, which may explain that only a small number of cores are identified. Some cores carry black casting surface that had direct contact with the molten metal, while others have no such casting surface. Only very few cores are decorated. Most cores were used for manufacturing bronze vessels such as *ding*, *jue*, *pan*, etc; a very few for weapons such as spear.

The specimen 2001AGH2:2 is a clay core carved with 11 characters “鬲公万(𠂔)敦辟, 作父辛尊彝 □,” and no other cores found at Yinxu carry such a long inscription. The core is constructed of clay material containing traces of fine sand; the surface color is green gray and the body light red. One tenon is seen on the top side of the outer surface. The middle and lower portion of the core bulges slightly, suggesting that the core was used for a round vessel and it was recessed onto the

master model. The specimen is 6.2cm high, 4.4cm wide, and 3cm thick (Figures 11; 13:3; 14).

Retouching and Finishing Tools

Tools for the production of bronze castings are also found at Xiaomintun Southeast. They are mostly whetstones for retouching and finishing cast bronzes; other tools include pottery paddles, bronze knives, bronze carving bits, and bone awls used for making clay models, molds, and cores.

Other Casting-related Remains

Other casting-related remains include pottery tubes, helmet-shaped vessels, red burnt earth blocks, charcoals, etc. A total of 14 ceramic tubes are found; they have a tapering shape often with a cap-shape at the wider end. Some tubes contain traces of bronze residue on the surface. They might function as tuyeres in use with the bellow for firing the furnace to melt the metal. Six broken “helmet-shaped” vessels are identified; they are very thick and constructed of coarse sand-clay mixture. The helmet-shape vessel, also called “the general’s helmet,” is often believed to be the crucible for melting the metal; but we consider it as a pouring vessel for transferring the molten metal from the crucible into the assembled casting molds.

Conclusions

The bronze foundry site at Xiaomintun Southeast is poorly preserved, making its precise dating very difficult. Upon the examination of unearthened pottery samples, most trash pits (or storage pits) and building foundations are dated to Yinxu Phase IV, and some to Yinxu Phase III. Only a very few features can be dated to Yinxu Phase II.

The types and styles of bronze vessels represented by unearthened clay molds are mostly of the late Yinxu phases. Some may be even as late as the end of the Shang or the beginning of the Western Zhou periods; examples include *gui* vessel with a pendant extended from the handle, *gui* vessel decorated with bosses and vertical ribbings, and rectangular stand decorated dragons and vertical ribbings, etc. There are also a few molds showing the style of Yinxu Phase II. All these suggest that the bronze foundry at Xiaomintun Southeast had a long span of operations, from Yinxu Phase II through Phase IV, even

into the beginning of the Western Zhou period.

Excavation reveals a considerable quantity of clay molds for casting ritual vessels, crucible fragments, and whetstones and other tools for bronze casting. Other casting remains include a kiln for baking clay molds and a working surface for polishing and finishing cast bronzes. All these suggest that the bronze foundry at Xiaomintun Southeast mainly involved making and baking clay molds, melting copper, casting, as well as re-touching/finishing cast bronzes. There are a great variety of bronze ritual vessels represented by unearthened clay molds, indicating that the foundry was a large-scale workshop especially specializing in the casting of ritual vessels.

The 2000–01 excavation suggests that the foundry site at Xiaomintun Southeast is about 1 hectare in area. Among the findings from a small excavation at Xiaomintun West in 1960 were foundry remains including clay molds, crucible fragments, tuyeres-like tubes, “the general’s helmets,” and whetstones; there were 320 pieces of clay molds, mostly for casting tools and weapons, some for vessels. More intensive excavations undertaken in 2003 and 2004 were carried out at the

Xiaomintun village; the foundry remains discovered far surpassed those at Xiaomintun Southeast in terms of the extent of foundry activities and the quantity of casting-related materials. It is most likely that the remains discovered at these three localities were of a single large-scale bronze workshop site that extends over an area of more than 5 hectares. We call this the “Xiaomintun Bronze Foundry Site,” and it is the largest foundry site at Yinxu.

The discovery of the foundry remains at Xiaomintun Southeast helps us understand the development of bronze casting during the late Shang period. Yinxu Phase IV saw the refinement of casting technology, involving the utilization of different clay materials for inner and outer layers of molds, the execution of both horizontal and vertical section divisions for outer molds, and the use of composite models, molds and cores. New types of bronze objects began to be cast, such as rectangular vessel stand and *gui* with a large pendant extended from the handle that were often identified as the product of the Western Zhou period.

Note: The original report, published in *Kaogu Xuebao* 考古学报 (Acta Archaeologica Sinica) 2006.3: 351–384, with 22 illustrations and eight pages of plate and three tables, is written by Yue Zhanwei 岳占伟. This summary is prepared by the author himself and English-translated by Jing Zhichun 荆志淳.