The emergence of pottery in China: Recent dating of two early pottery cave sites in South China

David J. Cohen a, *, Ofer Bar-Yosef b, Xiaohong Wu c, Ilaria Patania d, Paul Goldberg d, e

a Department of Anthropology, National Taiwan University, Roosevelt Rd., Sec. 4, No. 1, Taipei, 106, Taiwan
b Department of Anthropology, Harvard University, Cambridge, MA, 02138, USA
c School of Archaeology and Museology, Peking University, Beijing, 100871, China
d Department of Archaeology, Boston University, Boston, MA, 02215, USA
e School of Earth and Environmental Sciences, University of Wollongong, NSW, 2522, Australia

A R T I C L E   I N F O
Article history:
Available online 10 September 2016

Keywords:
South China
Upper Paleolithic
Pottery
Hunter-gatherers
Yuchanyan
Xianrendong

A B S T R A C T
The earliest pottery in East Asia, as is found in several cave sites in southern China, emerges in Upper Paleolithic contexts dating from the Last Glacial Maximum, ~20 Ka cal BP. The making of simple pottery vessels in Late Pleistocene East Asia also has been noted in eastern Siberia and Japan but not yet in the Central Plains of China. This paper summarizes the better-reported evidence for early pottery sites across the vast region of China south of the Yangtze River, providing details on two dating projects conducted in the cave sites of Xianrendong (Jiangxi Province) and Yuchanyan ( Hunan Province). The excavated contexts in these two caves and a few others clearly indicate that this early pottery was the creation of hunter-gatherers who hunted available game and foraged a variety of plant foods. The nature of the cave occupations is ephemeral, and where the published animal and plant remains allow, we suggest that there were repeated, seasonal occupations. In sum, there is no basis yet to suggest that the making of early pottery in South China marked sedentary or plant-cultivating communities.

© 2016 Elsevier Ltd and INQUA. All rights reserved.

1. Introduction

Research over the last several decades is making scholars increasingly aware that pottery manufacture by foragers was a common phenomenon in various regions of the Old World. In East Asia, in particular, pottery production now clearly can be seen to predate sedentism, cultivating cereals, and producing polished stone axes or adzes (Jordan and Zvelebil, 2009; Cohen, 2013). This recognition removes the production of pottery from the traits of the “Neolithic Revolution,” a term coined by G. Childe (1936) during the early part of the 20th century. Childe based his definition of the Neolithic on the then available archaeological evidence retrieved from sites across southwestern Asia (the Near East) and Europe, and this resulted in a widespread acceptance of certain cultural “markers” of the Neolithic, including pottery, ground stone tools, and cultivated plants; such traits later became termed the “Neolithic package” (Gibbs and Jordan, 2016).

Chinese archaeologists, arguably through Childe’s influence, long accepted the presence of pottery as indicative of a site being “Neolithic” and thus also typically assumed the site likely represented a sedentary occupation of plant cultivators. The discovery of early pottery in Late Pleistocene cave sites in South China originally lead excavators to believe these sites represented occupations by early domesticators of rice, but further work and dating of these sites, as discussed here, however, have led to the realization that pottery in China and greater East Asia was first produced by hunter-gatherers millennia before what in China are called “Early Neolithic” (here meaning sedentary plant-cultivator) sites appear. In China, sites with pottery that date from the Late Glacial Maximum to the early Holocene are now often referred to as “early pottery” sites, and they stand in contrast to the “Early Neolithic” sedentary sites that appear in the early Holocene. Although pottery predates plant cultivation and sedentism, and we must thus remove the invention of pottery from Childe’s list of traits marking the Neolithic, Childe’s conceptualization of a “Neolithic Revolution”— meaning a fundamental socio-economic transition from foraging to farming and herding that occurs across various geographic regions of the world with concomitant changes in ideologies and belief systems (see Bellwood, 2005)— is still valid in China and elsewhere. In this paper, we discuss the excavations and dating of pottery at the two earliest pottery cave sites in the world,
Xianrendong and Yuchanyan caves in South China, and place these caves and other sites in the greater context of Late and Terminal Pleistocene foragers in East Asia.

1.1. Early pottery across eastern Asia

With the onset of the application of radiocarbon dating, archaeologists realized that hunter-gatherers in Japan had been making pottery since the Terminal Pleistocene age. This appearance of pottery vessels within subsistence systems of hunting, fishing, and intensive collection of wild plants in the Late Pleistocene stood in immediate contradiction to Childre’s understanding of the role of pottery as he saw it in the Near East and Europe. Recent dating of the earliest pottery in what is now termed the Incipient Jomon culture in Japan ranges from 16.8–15.3 Ka cal BP (thousands of years, calibrated, before 1950 present) (e.g., Kudo, 2012; Craig et al., 2013; Yoshida et al., 2013). The earliest pots in Japan and elsewhere in East Asia were handmade ceramic containers fired at moderate temperatures, and, as vessels for storing, preparing, or cooking food, were conceptually different from the earlier use of fired clay for shaping figurines or small objects known from the Central European Upper Paleolithic period, such as at Dolní Věstonice (Jordan and Zvelebil, 2009; Svoboda et al., 2015). In later phases of the Jomon culture, “low level” plant food production, or what Crawford (2011) calls “resource production,” is recognized as pottery production becomes more and more highly elaborated (Kaner, 2009; Sato et al., 2011; Noshiro et al., 2016), demonstrating that the long tradition of making pots was a continuing activity by foragers that came to take on increasing socio-economic and ideological significance, together with the production of stone tools and objects of organic materials such as bone, antler, wood, and bamboo. Parallel situations, with the elaboration of pottery forms, decoration, functions, and meaning are witnessed as Early Neolithic societies emerge in North and South China ca. 10–9 Ka cal BP (Cohen, 2011).

Japan was not unique in the production of early pottery, as Late Pleistocene sites with pottery were also discovered in the Russian Far East and eastern Siberia, with a series of well-known sites indicating dates for the early pottery of ca. 14,000–15,940 cal BP (Buvit and Terry, 2011; Kuzmin, 2013, 2015; references therein; Tsydenova and Piezonka, 2015; Zhushchikhovskaya, 2009). This additional information from Russia made it fully acceptable that Terminal Pleistocene hunter-gatherers across a wide area of East Asia manufactured pottery, and so it was therefore not surprising that early, simple pottery began also to be found in Late and Terminal Pleistocene cave sites in southern China, as described below. At present, such early pottery, however, remains lacking from northern China, with the earliest pottery there dating to ca. post-12 Ka cal BP: these North China and Central Plains sites with pottery include Yujiaogou, Nanzhuangtou, Donghulou, Zhiuanmian, Lijiaogou, and Lingjing (Cohen, 2013; Wang et al., 2015; Li et al., 2016). With earlier pottery known to the north and south of these sites in North China, it is yet unknown why there is no earlier pottery in this region that becomes a major center of early sedentary, plant-cultivating villages in the Early Neolithic of the Central Plains (middle and lower Yellow River basin) in the early Holocene (see Cohen, 2011). It is quite possible that future excavations of more sites that are still buried in the loess deposits in the river valleys of northern China will reveal early pottery in Upper (or “Late”) Paleolithic contexts there.

2. Early pottery in South China

In the following pages we describe the finds from two early pottery-producing cave sites in South China, focusing specifically on issues of radiocarbon dating. The acceptance of the dating of early pottery-containing layers at these sites requires careful understanding of a number of inter-related issues that can impact the quality of the radiocarbon dates, including the selection of excavated areas, the digging techniques of the excavations, and the nature of the deposits in these South China sites. We define South China here as the broad region south of the Huai River and Qinling Mountains. Several cave sites in karst regions found south of the Yangtze River were excavated and published in one form or another, although final reports are still lacking for most. Sites include Xianrendong and Diao tongtouhuan in Jiangxi Province, Yuchanyan in Hunan Province, Qhedong in Fujian (Fujian Museum, 2013), and Miaoyan (Chen, 1999), Liyuzui (Liu Zhou Museum, 1983), Dayan, and Zengpiyan (Institute of Archaeology, Chinese Academy of Social Sciences, 2003) in Guangxi (Lu, 2010, Fig. 1), with the best-dated and earliest sites being Xianrendong and Yuchanyan, discussed here. These sites produced sufficient information to demonstrate that early pottery making occurred within the socio-economic contexts of hunter-gatherers and that they predate by some ten millennia or more sedentism and the emergence of farming during the early Holocene (Cohen, 2013).

2.1. Xianrendong Cave (Jiangxi Province)

Currently the site with the earliest known pottery vessels is Xianrendong Cave, with the earliest layers bearing pottery sherds exposed at the site dating to ~20 Ka cal BP (Wu et al., 2012, and references therein). Xianrendong Cave is located in Wannian County, northern Jiangxi Province, some 100 km south of the Yangtze River. The main cave consists of a large, dark hall with a small entrance, but the prehistoric occupations were in a roofed area at the front that resembles a rock shelter, in back of which is the dark main chamber. The frontal area can be divided by the entrance to the darker hall and an area of consolidated, unexcavated deposits into “Western” and “Eastern” areas. The first excavations were conducted in 1962 and 1964 by the Jiangxi Provincial Cultural Relics Administrative Committee, during which a major portion of the sediments was removed (Fig. 2). In 1993, 1995, a Sino-American expedition directed by Yan Wenming and S. MacNeish excavated a smaller portion of the deposits in order to derive a sequence for and date what was seen then as the emergence of rice cultivation at the site and the presence of early pottery. The field project was completed in 1999 by a team from the School of Archaeology and Museology of Peking University and the Institute of Archaeology and Cultural Relics of Jiangxi Province (MacNeish et al., 1998; MacNeish, 1999; Zhang, 2002a; Sun and Zhan, 2004;...
The Sino-American 1990s expedition also excavated a collapsed cave situated across the valley from Xianrendong originally called Wang Cave but which came to be known as Diaotonghuan Cave. The Diaotonghuan excavations covered a larger surface area and somewhat deeper deposits (MacNeish et al., 1998; MacNeish, 1999; Zhang, 2002a; Sun and Zhan, 2004; Peng and Zhou, 2006; Peking University School of Archaeology and Jiangxi, 2014). An extensive program for radiocarbon dating of both sites was carried out by dating facilities at Peking University (determinations labeled as BA) and the University of California Riverside (UCR). However, a number of critical issues that hindered the establishment of ages for the early pottery at Xianrendong from the old (1962, 1964) and new excavations (1993, 1995, 1999) emerged. These problems stemmed from the following:

1. A stratigraphic assumption was made in digging the East and West areas in Xianrendong cave in the 1990s that layers in these two, separate, small areas are horizontally equivalent (meaning the same depth equaling the same time period) and continuous. However, a distance of several meters of consolidated deposits separated the two areas. The assumption led to the unfortunate circumstance that layers in both trenches were labeled using the same numbering system, such as 2A, 3B1, 3C1A, 3C1B, although, in fact, a layer in the east would be different from one in the west with the same number. In addition to the basic assumption of there being correlations between east and west layers, the labeling system was not immune to labeling mistakes.

2. The trenches excavated in 1993 and 1995 were 1 m wide in the Western Area and in the Eastern Area. The limited sizes of these trenches made it difficult to identify misattributed or correlated stratigraphic units due to the lack of horizontal continuity.

3. It was apparently unclear to S. MacNeish, that the uppermost layers in the areas excavated in 1993 (E0-3N4) and 1995 (E11N10-12), when he was supervising the excavations in the cave, had been removed by the original 1962 and 1964 excavators. These removed layers were likely Holocene and primarily Neolithic, according to pottery and other artifacts found in the 1960s excavations. This removal may have impacted MacNeish’s conceptualization of the sequence of the site and not allowed him to realize that there could have been a longer developmental process for the pottery, thus also making him want to accept only the later dates for the earliest part of the sequence.

Fig. 1. Map of early pottery sites in South China mentioned in the text.
4 During the 1980s—1990s, it was a common—though incorrect—belief in China that the presence of whitish lenses in cave sites such as Xianrendong was the result of accumulated dripping of carbonates from the limestone ceilings, and that these impacted radiocarbon dating, producing “old” dates. This claim is clearly stated by An Zhimin (1991, p. 198) when he writes that “ground water in the region contains a great deal of CaCO3 which comes from dissolution of limestone and is depleted in radiocarbon.” On the other hand, An correctly mentions that “in general it is recognized that dates on shell are likely to be unreliable; much better results can be obtained from animal bone and tree charcoal” (An, 1991, p. 198).

5 The dating of the different layers at Xianrendong conducted by the two laboratories—Peking University and Riverside (California)—which in the 1990s already provided calibrated dates of over 19 Ka cal BP for the lowest pottery-containing layers, was not accepted by S. MacNeish, who led the American side in these joint excavations and who presented most of the dating evidence and descriptions of the excavations before they were recently collated in the published final report (MacNeish et al., 1998). MacNeish rejected 27 out of the 34 available radiocarbon dates. His rejection was based on two faulty premises: first, since Jomon pottery at the time was dated to not earlier than 12,000 BP, MacNeish believed the Chinese pottery could not be older, as he saw it as similar. Second, following the same belief of several Chinese authorities, expressed by An Zhimin, MacNeish also accepted that charcoal dates in limestone caves are too old due to dripping carbonate-containing water from the ceiling. However, we now know, as mentioned above, first, that Jomon pottery is over 16,000 years old, and second, based on dating and experimental work conducted in Western Europe and Israel, that the assumption of cave carbonates producing “old” dates is incorrect. This is because the white lenses thought to be carbonates from the ceilings are actually typically composed of calcitic white ash accumulated from burning wood, and the crystal morphology of this ash calcite, which can be distinguished from typical cave carbonates, is readily identifiable (Courty et al., 1989; Schiegl et al., 1994, 1996; Chu et al., 2008). Furthermore, the accumulated experience in cave and rockshelter sites across Eurasia now clearly demonstrates that in the majority of cases, well-preserved bones, as short-lived samples, and charcoal samples from plants, when they are identified, serve as a sound basis for dating past cultures when they generally are younger than 45–40 cal BP.

Additional fieldwork in Xianrendong and Diaotonghuan was conducted in the two caves in 1999, and a few more radiocarbon dates were obtained. The final site report covering the excavations through 1999, in Chinese, was recently published (Peking University and Jiangxi Province, 2014).

Following the 1999 excavations, the same issues and ambiguities in the Xianrendong radiocarbon chronology still remained. These, combined with problems with the suggested interpretations of the radiocarbon chronology of both sites, led a team including the authors Wu, Bar-Yosef, Goldberg, and Cohen, to conduct a short season of sampling in 2009 in Xianrendong Cave in order to re-date the deposits. As reported in Wu et al. (2012), we reopened previously excavated sections in the Eastern and Western areas to expose profiles to collect samples for micromorphological analyses in order to establish the nature of the deposits and site formation processes (Fig. 3, Fig. 4). We also collected new dating samples from the sections and enhanced this collection with selected bone samples.
Fig. 3. Western Area profile at Xianrendong Cave exposed during the 2009 excavation, with positions of radiocarbon determinations (from Wu et al., 2012). Hashed rectangular areas are locations of micromorphology block samples 1–7 and 13. The earliest pottery was recovered from layer 3C1B in this area, which is chronologically equivalent to layer 2B in the Eastern Area profile, where the earliest pottery is found in the eastern area of the cave (Fig. 4). These earliest pottery layers can be dated to ca. 20 Ka cal BP.

Fig. 4. Eastern Area profile at Xianrendong Cave exposed during the 2009 excavation, with positions of radiocarbon determinations (from Wu et al., 2012). Rectangles are locations of micromorphology block samples 19, 20, 22–26, and 29. The earliest pottery was recovered from layer 2B in this area of the cave, which is chronologically equivalent to layer 3C1B in the Eastern Area profile (Fig. 3). These earliest pottery layers can be dated to ca. 20 Ka cal BP.
As described above, when MacNeish established his chronology for Xianrendong in the 1990s (MacNeish et al., 1998), he rejected the majority of the radiocarbon determinations from the excavations, for incorrect reasons, because he felt they were "too early." Instead, MacNeish selectively chose a small number of what today are easily recognized as outlier dates if they are considered amongst the entirety of dated samples from the site. He chose to use these dates and ignore the others because they matched his preconceptions for the dating of the early pottery: he simply ignored the great majority of the dates because they were older than he thought they should be. The re-dating of Xianrendong reported in Wu et al. (2012) clearly demonstrates that the "too early" dates for the oldest pottery-containing levels rejected by MacNeish in fact truly reflect the actual age of these layers and the pottery in them, which we dated to 20–19 Ka cal BP.

Kuzmin (2013, 2015), however, attempts to argue that MacNeish was correct in rejecting the many "early" determinations in favor of a small number of outlier "younger" dates, but his reasoning is faulty. Kuzmin (2015, p. 3) argues that "age-depth reversals are common at this site", but his support of this is weak. What he means by "reversals" is that three dates from the entire sequence appear to be out of order in terms of their dates and stratigraphical positions, and he thus assumes that this can only be explained by major disturbances in the layers of the site which would have inverted some of the deposits or caused major movements of the dated samples post-depositionally. We should also point out that Xianrendong has an incredible 45 radiocarbon determinations available, so three samples would not be representative of a "common" occurrence. Even more importantly, among the three dates he cites, two are from several layers (3B1 and 3B2) above the early pottery levels, so even if there were "reversals" here, they have no bearing on the early pottery layers below. Also, these two samples, BA09318 and UCR5361, cannot be said to both be out of sequence because they are in order next to each other—at most, one could be out of sequence: if you reject one of them, the other falls into the remaining sequence, particularly if you take into account that BA093181 is a charcoal date and could therefore be subject to the "old wood" problem, meaning that its date is too old due to either the age of the tree itself or the length of time that the wood was available for use before being deposited at the site (this is why animal bone or short-lived plant samples provide more reliable radiocarbon dates). Kuzmin also cites UCR3300 in 3C2, which is some 2–3000 calibrated years younger than the other 4 samples in this layer below the earliest pottery. Kuzmin does not mention that this sample is a human bone fragment. Since it is human bone and there were burial features in upper levels at the cave, this invites the possibility that the excavators may have missed an intrusive burial feature that possibly cut into this layer, thereby excavating it as part of layer 3C2 and not recognizing it as a separate feature, perhaps due to the small area excavated. Layer 3C2 is reported as being up to 76 cm thick in places (Peking University School of Archaeology and Jiangxi, 2014, p. 17), and was not subdivided. Also, as we mentioned above, layers such as 3C2 were defined in such a way that they were thought to extend across the entirety of the West Area as one stratigraphic unit, and were excavated as such, and so there is no detailed reporting on small features, substrata, or lenses.

Kuzmin’s argument also ignores the fact that the Eastern Area dates for the earliest pottery layers and the rest of the sequence mirror those in the Western Area, so there is consistency across the two separate areas of the site. Kuzmin (2015, p. 4) also writes that there is a “lack of association” between bone samples collected in 2009 and the pottery, but again, the associations in 2009 are exactly the same as they were in the 1990s: the bone samples and the pottery come from the same stratigraphic contexts, which the original excavators defined by their level and sublevel system, and this was followed in 2009. Another major weakness with Kuzmin’s argument—and this one is key—is that he completely ignores the micromorphological analysis of the Xianrendong deposits and tries to base his argument for stratigraphic problems solely on a few radiocarbon dates without even looking at the geoarchaeology of the contexts of the samples—i.e., the stratigraphy itself—which was a central feature of the Xianrendong study by Wu et al. (2012).

The micromorphological analysis of the Xianrendong thin sections shows that the overall stratigraphic contexts from which the samples came were stable and not subject to "age-depth reversals" as Kuzmin would like to believe. The analysis also helps to show why a few of the samples can be rejected as outliers, rather than rejecting the great majority of samples, as Kuzmin wants to do (Wu et al., 2012) (Tables 1 and 2).

Table 1
Radiocarbon determinations from Xianrendong Western Area (after Wu et al., 2012).

<table>
<thead>
<tr>
<th>Layer</th>
<th>Lab-no.</th>
<th>14C date</th>
<th>Calibrated age range yr BP 1e3</th>
<th>Material</th>
<th>Calibrated age BP 1e3</th>
</tr>
</thead>
<tbody>
<tr>
<td>2A</td>
<td>BA09891</td>
<td>10210 ± 50</td>
<td>11777–12053</td>
<td>bone</td>
<td>11,914 ± 139</td>
</tr>
<tr>
<td>3A</td>
<td>BA09894</td>
<td>12240 ± 55</td>
<td>14050–14559</td>
<td>bone</td>
<td>14,305 ± 254</td>
</tr>
<tr>
<td>3B1</td>
<td>BA093181</td>
<td>14610 ± 290</td>
<td>17395–18342</td>
<td>ch</td>
<td>17,869 ± 473</td>
</tr>
<tr>
<td>3B2</td>
<td>UCR3561</td>
<td>14240 ± 80</td>
<td>14302–15003</td>
<td>human bone</td>
<td>14,653 ± 250</td>
</tr>
<tr>
<td>3C1A</td>
<td>BA09872</td>
<td>14235 ± 60</td>
<td>17448–17700</td>
<td>bone</td>
<td>17,448 ± 252</td>
</tr>
<tr>
<td>3C1A</td>
<td>BA09868</td>
<td>14092 ± 70</td>
<td>17397–18462</td>
<td>bone</td>
<td>18,218 ± 244</td>
</tr>
<tr>
<td>3C1A</td>
<td>BA09875</td>
<td>13885 ± 55</td>
<td>16932–17333</td>
<td>bone</td>
<td>17,128 ± 195</td>
</tr>
<tr>
<td>3C1A</td>
<td>BA09874</td>
<td>15165 ± 55</td>
<td>18061–18576</td>
<td>bone</td>
<td>18,319 ± 257</td>
</tr>
<tr>
<td>3C1A</td>
<td>BA00006</td>
<td>15655 ± 194</td>
<td>18655–19200</td>
<td>bone</td>
<td>18,928 ± 272</td>
</tr>
<tr>
<td>3C1A</td>
<td>UCR3562</td>
<td>16010 ± 70</td>
<td>18932–19373</td>
<td>human bone</td>
<td>19,153 ± 220</td>
</tr>
<tr>
<td>3C1A</td>
<td>BA05143</td>
<td>16340 ± 200</td>
<td>19187–19966</td>
<td>ch</td>
<td>19,577 ± 389</td>
</tr>
<tr>
<td>3C1B8</td>
<td>BA10264</td>
<td>16105 ± 55</td>
<td>19030–19536</td>
<td>bone</td>
<td>19,283 ± 253</td>
</tr>
<tr>
<td>3C1B8</td>
<td>BA10266</td>
<td>16485 ± 55</td>
<td>19500–20102</td>
<td>bone</td>
<td>19,801 ± 301</td>
</tr>
<tr>
<td>3C1B8</td>
<td>UCR3439</td>
<td>16730 ± 120</td>
<td>19659–20270</td>
<td>ch</td>
<td>19,965 ± 305</td>
</tr>
<tr>
<td>3C1B8</td>
<td>BA00007</td>
<td>16915 ± 186</td>
<td>19821–20533</td>
<td>bone</td>
<td>20,177 ± 356</td>
</tr>
</tbody>
</table>

(continued on next page)
Micromorphological analyses show that the deposits in the Western Area were formed by low energy alluvial processes (slackwater deposition), and are consistently composed of compact sediments. Low porosity and the absence of pedality and bioturbation signal that artifacts and radiocarbon samples recovered from the early pottery layers were not displaced post-depositionally. The Eastern Area, where most of the anthropogenic material is found, contains slightly more evidence for bioturbation and diagenesis. However, it is important to underline that this bioturbation is not prevalent and that it occurs only on a small scale: disruption of the matrix due to insect passages are never larger than 9 mm in diameter and are not pervasive enough to support any hypothesis of mixing of sediments or translocation of objects and charcoal, and particularly of radiocarbon samples of the size that we selected, which was over 1 cm. Continuing analysis of the micromorphology since 2012, to be described in detail in a paper in preparation, supports our conclusions in Wu et al. (2012), that post-depositional disruption of the sediments at any given time was very low. These observations confirm the inference that the bulk of the radiometric dating samples published in 2012 (Wu et al., 2012) were in fact in place and not moved post-depositionally, as Kuzmin would like to believe.

The dates that Kuzmin believes do not fit the sequence should have been explained by the original excavators in combination with more details of the exact excavation contexts, but MacNeish et al. (1998), never did this in their reports, and we can only offer an explanation based on our observations. The date BA 093181 was probably derived from layer 3B2 and not 3B1, a mistake that could be attributed to the same color of sediments that prevailed in this area. The rest of the dates, distributed over deposits that are hardly above it (3C1B), ~21.78 ka cal BP.

Finally, we should note that most of the human bone remains recorded by MacNeish et al. (1998; Table 7) were found in the Western Area and date to the Terminal Pleistocene. The three human bone fragments from the Eastern Area are dated to the Holocene. This supports the information about the removal of the upper layers during the 1962 and 1964 excavations.
In the Eastern section the overall thickness of the early pottery-bearing layers is about 20–30 cm, with sherds found clustered in layers 2A2, 2B1, and 2B2. The dates range between 20.9 and 19.5/19.0 ka cal BP. The bone dates are slightly younger than the charcoal dates, so we took the most conservative approach to dating the onset of pottery making by using the younger dates for determining the age of the pottery, and we concluded that pottery making would have begun by 20/19,000 cal BP.

What did this pottery made during the Last Glacial Maximum by hunter-gatherers at Xianrendong look like? The pottery was made in two ways (Zhang, 2002a, 2002b). The first technique was a form of slab construction in which the potter joined sheets of clay together in layers extending upward to form the vessel walls. The vessel surfaces were either decorated with parallel striations (called “stripe-marked” by the excavators) formed by scraping a tooth-edged tool across the interior and exterior, or had plain surfaces, resulting from hand smoothing after scraping (Fig. 5). Vessels of this manufacturing technique were the earliest uncovered, with sherds found in layers 3C1B and 3C1A in the Western Area. Rim sherds of both plain and stripe-marked pottery could be decorated with regularly spaced U- or V-shaped notches, and several rows of irregularly spaced punctuates appear under some rims formed by punching a stylus into the exterior surface, which caused raised dots on the interiors, as well.

The second manufacturing technique, coiling and paddling, occurred later in the sequence. Coiled pottery was tempered with quartzite or even crushed pottery sherds, and the exterior surfaces and rarely the interior are covered by impressions similar to cord-marking, which appears to have been applied by a paddle wrapped in cordage or fibers: this is found in layer 3B2 and above (MacNeish et al., 1998; Zhang, 2002a, 2002b; Wu et al., 2012; Peking University and Jiangxi Province, 2014). This description also fits the finds from Diaotonghuan Cave, where the number of radiocarbon dates is very small: Diaotonghuan’s earliest pottery, from Zone D (zone is the designation for the layers), likely should date to the same period as the early Xianrendong pottery-bearing deposits (Peking University and Jiangxi Province, 2014, p. 196).

In addition, it is important to remark that the dated stratified contexts at Xianrendong and Diaotonghuan (MacNeish et al., 1998) indicate that the caves were occupied intermittently by foragers over a period of up to 17 millennia. The first use of these caves occurred around 28 ka cal BP, and these are only seen in the Eastern Area of Xianrendong and Zone K in Diaotonghuan. Pottery making began in layers 3C1B in the Western Area and in layer 2B1 in the Eastern Area at Xianrendong. The dates for these earliest pottery layers of ca. 20/19 ka cal BP coincide with the warming phase at the end of the LGM, when monsoon precipitation increased in the region. The two caves were abandoned during the Heinrich 1 cold event (ca. 16.5–15.0 ka cal BP) (see Wang et al., 2002; on a speleothem record for South China; Wang et al., 2012; on southern China lake sediments pollen), were re-occupied sometime later from 14 to 12 ka cal BP (Bølling-Allerød through the Younger Dryas), and then were deserted at the onset of the Holocene.

Subsistence activities at Xianrendong have not been studied in great detail. Studies of rice phytoliths at the site show changing patterns of wild plant exploitation, represented mainly by rice phytoliths, by hunter-gatherers at the cave (Zhao, 1998). Hunted game, evidenced by bone fragments, include mostly the remains of one deer species (Cervus nippon) and smaller amounts of bones of other deer species (Muntiacus sp., Moschus sp., and Hydropotes inermis), but there have been no taphonomic studies done of the bone, and such studies remain limited in China (for examples, see Lam et al., 2010; Prendergast et al., 2009). Second in abundance to deer, but less than the three deer species, is wild boar, and there was a minimal presence of several carnivores and a few rodents (Peking University and Jiangxi Province, 2014). In addition, the lithic industry in the early pottery layers is of the cobble tool type, typical of the South China Late Paleolithic, in which chopper-chopping tools are found together with bone and antler objects with polishing (including awls, points, barbed points, spades, scrapers), and large Unio shell tools, many with central perforations (Peking University and Jiangxi Province, 2014). The late cobble tool assemblages in South China, such as at Xianrendong and Yuchanyan, which begin ca. 24 ka cal BP, continue out of Pleistocene core and flake and then cobble tool industries and likely coincide with the extent of bamboo forests in this region and extending into Southeast Asia (Bar-Yosef, 2015); one hypothesis for why this conservative lithic industry persists in South China is that chopping
tools and flakes may have been used to fashion more complex tools and cutting edges on bamboo or other organic materials (Bar-Yosef et al., 2012). The stone tools that are found in the early pottery contexts are the same as those found throughout southern China in the wide-ranging cobble tool tradition, and include one-sided choppers, heavy-duty choppers, and flakes, more similar to Lower and Middle Pleistocene assemblages than to Upper Paleolithic stone tools in western Eurasia, while there are also examples of unique types such as perforated cobbles (perhaps used on digging sticks) and cobbles with “cupholes” (possibly used for cracking nuts or processing pigments) (Bar-Yosef, 2015; Qu et al., 2012).

2.2. Yuchanyan (Hunan Province)

Yuchanyan Cave is located in Daoxian County, Hunan, some 450 km south of the Yangzi River. It is a karstic cavity in one of the “sugar cone” hills in this karst region that stretches west into Guangxi Province, where the cave of Zengpiyan is located. Excavations were first conducted in 1993 and 1995, and again by a Sino-American team in two seasons, in 2004 and 2005 (Yuan, 2000, 2002, 2013). The upper part of the deposits in the cave had been removed by local farmers previous to the excavations, and in addition, several historical burials were dug into the existing upper layers of the prehistoric accumulations. However, the rest of the layers were not affected by post-depositional disturbances, except for minimal rodent activity.

The 1990s excavations recovered two clusters of sherds from which a conical-shaped pottery cauldron and a large fragment of a second vessel could be reconstructed. The 2004–5 excavations found two additional sherds in the same layer where the earliest pottery fragments were previously discovered (layer 3H). An extensive dating project carried out during the 2004–5 excavations seasons focused on the northern area, where the preserved deposits are about 1 m thick and where the pottery fragments were recovered (Boaretto et al., 2009) (Fig. 6). The stratigraphic distribution of the dates (Table 3) indicates that most of the occupational sequence, likely made up from seasonal visits by hunter-gatherers, took place after the LGM.

Micromorphological and mineralogical studies of the Yuchanyan deposits show that they are mainly anthropogenic (rather than formed by natural karstic activity in the cave as has often been assumed at other cave sites in China without further testing) (Fig. 7). These deposits consist of ash, charcoal, and bone, suggesting that humans built wood fires in the cave and likely used them for cooking (based on faunal remains). The deposits include several in situ fire features as well as many lenses composed of the remains of fires.

From a preliminary micromorphological analysis, horizontal deposits of allochthonous red kaolinite clay, which had to be
The construction of prepared clay surfaces is a documented behavior in several Late Pleistocene and early Holocene sites. Some of these have been investigated using micromorphology. In the cave site of Klioora in Greece, clay was used to line fire-pits and create a surface onto which nuts and other plant material could be roasted (Karkanis et al., 2004). Clay surfaces also were constructed in Native American sites during the Early Holocene. For example, clay surfaces at the Icehouse Bottom (Tennessee) and Dust Cave (Alabama) sites have both been analyzed using micromorphology (see Sherwood et al., 2004; Sherwood and Chapman, 2005). In these two sites, the clay surfaces were also connected to fire features and were subject to multiple firing temperatures. At Yuchanyan, a complete study of the micromorphology and geoarchaeology of the cave is still ongoing, and this will lead us to a fuller understanding of the context of these surfaces at Yuchanyan within the greater discussion of human activities within the cave.

While Xianrendong pottery remains were limited to sherds, Yuchanyan early pottery includes a reconstructable vessel and a large fragment of a second vessel, so it provides the earliest full understanding of the context of these surfaces at Yuchanyan.
evidence for a complete vessel form. The pottery is crumbly and coarsely made with thick, uneven walls up to two cm thick. The clay matrix has inclusions of charcoal, crushed quartz, and water-polished pebbles up to 5 mm in size. The pottery was fired at moderate temperature, perhaps 600 °C. The one reconstructed vessel, in the shape of a cauldron, was formed by attaching slabs of clay together (Fig. 8). It is conical in shape with a pointed base, stands 29 cm high, and opens to a mouth diameter of 31 cm. The interior and exterior surfaces of this vessel and the other pottery fragment appear to be impressed with cordage (Boaretto et al., 2009; Yuan, 2002, 2013).

Yuchanyan deposits, like those in Xianrendong, are rich in cervid remains including sambar, Pere David deer, water deer, muntjak, musk deer, and sika deer, as well as many aquatic birds (Prendergast et al., 2009). Deer, by the amount of bone remains, provided most of the meat, and breakage patterns may indicate processing for maximal grease and marrow extraction. Some of the waterfowl were migratory species that can be used as indicators of seasonal occupations by humans at the site in the winter.

Combined with evidence for seasonal occupations, the extensive series of radiocarbon dates from Yuchanyan (Boaretto et al., 2009) allows us to see repeated human presence and gaps in the occupation sequence of the cave, with an early or natural deposition at ca. 20 Ka cal BP, an occupation at ca. 18 Ka cal BP when the pottery was produced, and then briefer occupation periods at ca. 16 and 15.5 to 14.5 Ka cal BP. Most of the preserved deposits date to 14.3 through 13.8 Ka cal BP, which corresponds to a warming period in East Asia equivalent to the Bølling-Allerød. As the top layers are missing, it is difficult to affirm when the cave was abandoned.

3. Conclusions

The presence of pottery made by hunter-gatherers long before the Neolithic Revolution challenges the old concept accepted by many schools since the days of Gordon Childe that pottery is tied to sedentism and agricultural production (Jordan and Zvelebil, 2009). The presence of pottery in Late Pleistocene Upper Paleolithic contexts in South China (and elsewhere in East Asia) well before the sedentary sites of plant-cultivating groups of the Neolithic appear in the early Holocene raises the question that is in many ways easier to answer when we are dealing with farming communities—what purpose did early pottery serve? In Early Neolithic village sites, pottery is ubiquitous and can be seen to fill many roles in sedentary domestic activities, such as food and beverage preparation, cooking, and storage. But in the more ephemerally occupied Late Paleolithic cave sites of hunter-gatherers in South China, with only small amounts of pottery found, we are still at a preliminary place in our understanding of its roles, and as expected, the answers to...
this question offered in the literature, are numerous and still far from conclusive. Most prefer to see these rare occurrences of mostly individual pots (or more often, a few remaining sherds of a pot) in the earliest phases of pottery production as employed as kitchen equipment. Their rarity immediately motivated some scholars to see them as produced for use in special circumstances, rather than for daily use, especially in feasting (e.g., Hayden and Villeneuve, 2011), and if this is the case, the early pottery had an important social and perhaps ideological function, much more so than just being a utilitarian object.

In China, there have been no formal studies of the early pottery remains from the earliest cave sites yet, and so we have little evidence as to their use. Residue analysis is still in its infancy in East Asia but could perhaps offer some interesting results, as it has in a few studies of Jomon pottery. Craig et al. (2013) demonstrate through analysis of lipids in pottery residue that a series of Jomon vessels from 15 to 11.8 ky cal BP were used almost exclusively for cooking marine and freshwater organisms. Another Japanese example recently published demonstrates through molecular and isotopic analyses of lipid residues from 143 vessels recovered in the 9000-year sequence from Tomihara, a Jomon site in western Japan, that this role of pottery continues there as well, with the pottery through most often used for cooking marine and freshwater resources (Lucquin et al., 2016), with almost no indications of terrestrial animal or plant processing. Given the different continental, inland ecozones of the South China sites, we should expect that the pottery at Xianrendong and Yuchanyan was used for cooking other foods, and the rich faunal record at Yuchanyan (with a predominance of various species of deer, as well as waterfowl) and how the animals were processed, particularly for grease extraction, may offer some clues (see Prendergast et al., 2009).

As the amounts of pottery produced, the diversity of its forms, and the dispersal patterns of pottery change through time (with pottery becoming more widespread across regions and more prevalent at individual sites), so, too, perhaps, do the roles of pottery. Therefore, to understand the invention of pottery during the Terminal Pleistocene and its dispersal and adoption, we must consider its contexts and scales of use across not only different time periods, but also at the regional, inter-site, and intra-site level. Also necessary to consider is that during the same time when a few early pots were made, there were other, contemporary sites within the local region without pottery: why was pottery used at some sites but not others of similar size and with similar cultural assemblages? Pearson (2005), who examined the phenomenon of early pottery in South China sees no evidence of social differentiation as a cause for the new technology of pottery, but also argues that pottery could be used for feasting as markers of a collective event for building social cohesion. For South China, we need to continue to build models for testing the use and roles of early pottery and to apply more analytical methods to understand the properties and use of recovered pottery remains.

Understanding the roles of pottery in South China, as elsewhere, will take a number of steps, and we are at the earliest stages of this process. First, there must be excavations with careful stratigraphic controls and reconstruction of the formation processes of the pottery-containing contexts. Second, the pottery must be well dated, and this would typically involve dating its stratigraphic contexts, as at Xianrendong and Yuchanyan, and testing the reliability of the dating samples and security of their contexts, such as through micromorphology. There must be physical and chemical studies of the pottery, including residue analyses as well as usewear, petrographic, and firing studies, among others, and experimental studies to understand pottery production and use. The more data that can be brought to bear on understanding the roles of early pottery, the better our understanding will be, and we are currently only at the start of this process.

References


