

Chronology of the earliest pottery in East Asia: progress and pitfalls

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The origin of pottery is among the most important questions in Old World archaeology. The author undertakes a critical review of radiocarbon dates associated with the earliest pottery-making and eliminates a number of them where the material or its context are unreliable. Using those that survive this process of 'chronometric hygiene', he proposes that food-containers made of burnt clay originated in East Asia in the Late Glacial, c. 13 700-13 300 BP, and appeared in three separate regions, in Japan, China and far eastern Russia, at about the same time.

Keywords: East Asia, Neolithic, Palaeolithic-Neolithic transition, pottery, radiocarbon dating

Introduction

The origin of pottery manufacture is one of the most important subjects in Old World prehistory. Since the mid-1960s, the Jomon of Japan was considered as the archaeological complex with the earliest pottery in the world dated to the Final Pleistocene, c. 12 700-12 200 radiocarbon years ago (hereafter BP) (e.g. Morlan 1967). From the 1970s to the 1990s, the increased pace of archaeological and chronological studies in East Asia has brought to light new evidence of the Final Pleistocene pottery in other regions neighbouring Japan, such as China and the Russian Far East. In East Asia, the presence of pottery is very often associated with the Neolithic stage in prehistory (e.g. Barnes 1999: 17) although in the earliest sites important indicators of the Neolithic in its classical definition, agriculture and sedentism, are missing. Thus, the meaning of the term 'Neolithic' in East Asia is different from that in Europe and the Near East.

The main aim of this paper is to present an updated review of the chronological aspects of pottery origins in East Asia, with a critical evaluation of the latest summaries. The 'chronometric hygiene' approach (*sensu* Spriggs 1989) is applied to the archaeological complexes with the earliest pottery in East Asia, meaning that the radiocarbon dates are critically assessed and unreliable ones are rejected.

Materials and Methods

Pottery in this review is defined as 'clay that has been fashioned into a desired shape and then dried to reduce its water content before being fired or baked to fix its form' (Darvill 2002: 337-8). For our purpose, those sites with radiocarbon (hereafter ¹⁴C) dates directly associated with the earliest pottery were chosen. The sites are located in China, the Japanese

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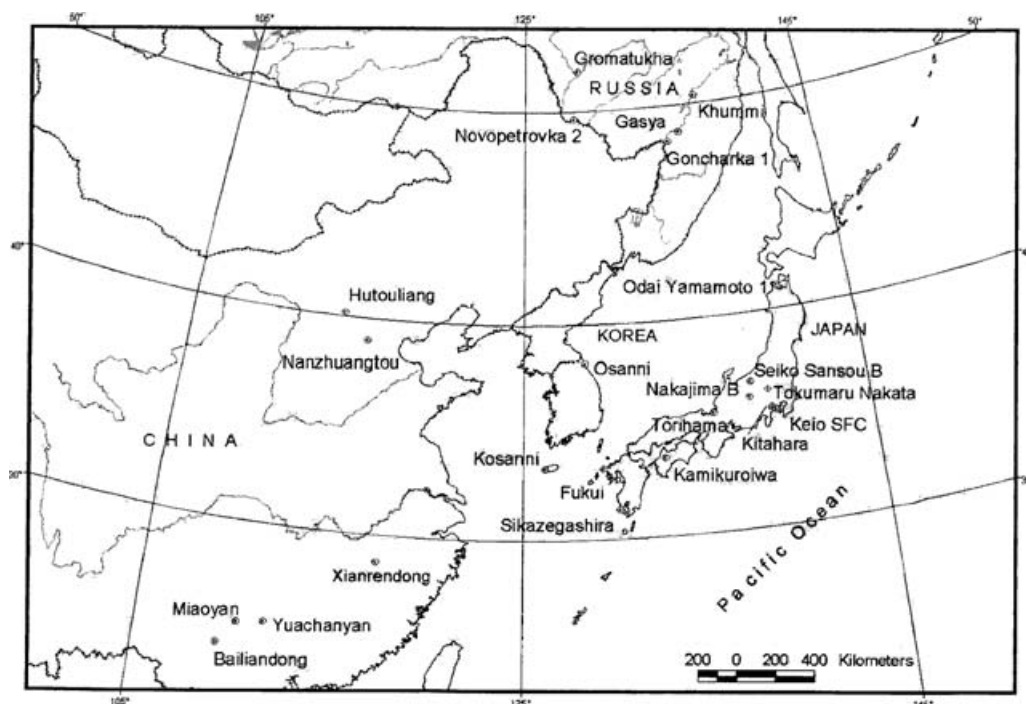


Figure 1. Position of the earliest pottery sites in East Asia and other sites discussed in this paper.

islands, the Russian Far East, and Korea (Figure 1). All the sites meet the criteria for establishing the presence of pottery in archaeological contexts (Vandiver 1999). In order to evaluate the reliability of the ^{14}C dates associated with pottery, critical assessment of different chronological aspects were addressed. These included the materials dated, the methods for direct ^{14}C dating of pottery, the degree of association between ^{14}C dates and potsherds from particular cultural layers, and the correspondence of the earliest pottery ^{14}C dates with general cultural chronologies. Dates that do not fulfil the 'chronometric hygiene' requirements, such as consistency in stratigraphy, secure association of ^{14}C -dated material and pottery, adequate reporting of original data, and correspondence to the general chronological outline of prehistoric cultural complexes, were rejected after explaining why they were not considered to be reliable.

In this paper, comprehensive summaries with lists of ^{14}C dates were used (Wu & Zhao 2003; Keally *et al.* 2003; Kuzmin & Shewkomud 2003). Figure 2 shows the calibrated ages of the most reliable earliest ^{14}C values associated with pottery. Chinese dates, originally reported with 5730 yrs ^{14}C half-life, were re-calculated for the 'Libby value' of 5568 yrs, to be compatible with other dates produced elsewhere. The CALIB rev. 4.4.2 software was used for date calibration.

For the ^{14}C data corpus used in this review, the materials dated include wood, charcoal, food residues (adhesions), human and animal bones, freshwater shells, and potsherds. Wood, charcoal, bone, shell, and humic acid pretreatment procedures are quite standardised now (cf. Taylor 1987: 44-61). For the direct dating of food residues and pottery, several pretreatment

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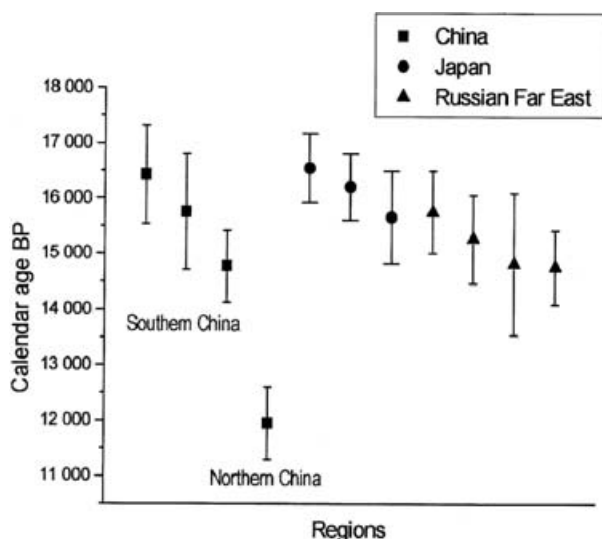


Figure 2. Calibrated ages of the earliest pottery-associated ^{14}C dates from East Asia.

protocols were used. For the extraction of carbon from the charred food remains attached to the potsherds, Nakamura *et al.* (2001) used acid-alkali-acid pretreatment, with a weaker concentration of alkaline solution to prevent the loss of carbon.

Direct dating of pottery is a more difficult task (see review in Bonsall *et al.* 2002). For plant-fibre-tempered pottery from the Russian Far East and the Kosan-ni site in Korea, O'Malley *et al.* (1999) used low temperature combustion with oxygen. For the Kosan-ni pottery, the method of alkali extraction of organics was also used (Bae & Kim 2003). Another method for carbon extraction, using methyl benzene and alcohol to separate the lipids, which represent the soluble portion of the sherds, from the insoluble part, was applied by Zhao and Wu (2000) for non-organic-tempered pottery excavated in southern China.

The earliest pottery in East Asia: a review of ^{14}C dates

China

The first Final Pleistocene ^{14}C dates associated with pottery in China became available in the 1980s (e.g. An 1989). In the 1990s, the number of dates increased substantially (MacNeish & Libby 1995; Zhao & Wu 2000), and there are now at least five sites dated to earlier than *c.* 10 000 BP: Miaoyan and Bailiandong in Guangxi Province, Yuchanyan in Hunan Province, Xianrendong in Jiangxi Province, and Nanzhuangtou in the Beijing metropolitan area (Figure 1). Three other sites, Diaotonghuan (Wu & Zhao 2003), Liyuzui and Hutouliang (Yasuda 2002), in my opinion have problems with dating and stratigraphic context, and should not be accepted as pre-10 000 BP Neolithic complexes without additional studies (see below).

The recent set of ^{14}C dates run on charcoal for the earliest pottery-containing sites in southern China allows us to estimate the age of pottery as $13\,680 \pm 270$ BP (BA95058) for the Yuchanyan site and $13\,310 \pm 270$ BP (BA92034-1) for the Miaoyan site (layer 4M)

(dates correspond to 17 320–14 710 cal BP) (Figure 2). A ^{14}C date of $18\,140 \pm 320$ BP (BA92036-1) from pre-pottery layer 5L at the Miaoyan site provides good stratigraphic control of the date for pottery layer 4M. At the Miaoyan and Yuchanyan sites, direct dating of pottery was applied (Zhao & Wu 2000). The ^{14}C values on insoluble residues are $14\,390 \pm 230$ BP (BA95057b) for Yuchanyan, and $15\,220 \pm 260$ BP (BA94137b) for Miaoyan (layer 5).

However, pottery residue dates should be treated as maximal age estimates. Because no organic matter was added deliberately by humans during the manufacture of pottery at both Miaoyan and Yuchanyan (Zhang 2002a, 2002b: 34), the age of the pottery itself does not necessarily correspond to the timing of its production, and the charcoal ^{14}C dates, *c.* 13 700–13 300 BP, are in my opinion the most reliable age determinations.

The Xianrendong cave is among the most thoroughly dated sites in southern China (MacNeish & Libby 1995; MacNeish *et al.* 1998; Wu & Zhao 2003). The charcoal ^{14}C date from the earliest pottery-containing component of this site, zone 3C1b, is $12\,430 \pm 80$ BP (UCR-3561). The overlying zone 3C1a has a charcoal date of $12\,170 \pm 140$ BP (BA95145), indicating good stratigraphic control. Furthermore, two older bone ^{14}C values were obtained recently for this site in presumed association with pottery: zone 3C1b, $15\,960 \pm 190$ BP (BA00009) and zone 2B, $15\,830 \pm 160$ BP (BA00015).

However, the very complicated stratigraphic situation at Xianrendong and inversions in the ^{14}C age do not allow us to accept these earlier dates at face value. For example, from zone 3B1, lying stratigraphically above zone 3C1b, there is a ^{14}C date of $14\,185 \pm 290$ BP (BA93181) on unspecified material. Furthermore, a ^{14}C value of $17\,420 \pm 130$ BP (AA-15008) was obtained on charcoal from zone 3C1b. The date of $15\,180 \pm 90$ BP (URC-3300) for human bone from zone 3C2 is younger than another date from zone 3C1a, $16\,010 \pm 60$ BP (UCR-3562) on unspecified material, although zone 3C2 is stratigraphically below zone 3C1a. These examples demonstrate the disturbed nature of the Xianrendong cultural sequence due to re-deposition of archaeological materials by human activity in the cave throughout its long-term occupation, since at least *c.* 20 000–17 000 BP (MacNeish & Libby 1995: 87). Perhaps this is why MacNeish *et al.* (1998: 39) finally accepted the age of the earliest pottery as *c.* 13 500–11 800 BP.

At the Diaotonghuan (or Wang Dong in MacNeish *et al.* 1998) cave site in Jiangxi Province close to the Xianrendong site, a ^{14}C date of $14\,650 \pm 210$ BP (BA00014) was recently determined on bone material from zone D (Wu & Zhao 2003). Higham (2002: 338–9) is sceptical about such an early age of Diaotonghuan zones D and E, and estimates the age at *c.* 10 000–8000 BP. Zhao (1998) accepts a ‘conservative date’ of *c.* 9000–10 000 BP for zone E, and *c.* 8000 BP for zone D. Zhang (2002a: 190) correlates zones D1 and D2 with zones 3B1 and 3B2 of Xianrendong, dated to *c.* 11 000 BP (MacNeish *et al.* 1998). More dates, especially on charcoal, are necessary to secure control of the Diaotonghuan stratigraphic sequence. Until then, the single value of *c.* 14 700 BP can be treated only as provisional.

Two sites with quite early ^{14}C dates, presumably associated with pottery, were recently reported by Yasuda (2002). Two freshwater mollusc shell dates of $18\,555 \pm 300$ BP (PV0379-1) and $21\,025 \pm 450$ BP (PV0379-2) from the Liyuzui shellmidden site in Guangxi

Province (corresponding to 'Libby' half-life dates of $18\,030 \pm 300$ BP and $20\,430 \pm 450$ BP, respectively), were originally received in the early 1980s (Radiocarbon Dates 1991) and soon rejected by Chinese scholars (cf. An 1991: 198-9; see also Zhang 2002b: 29). Zhao (1998) assumes that the age of the Neolithic component at this site is no older than *c.* 11 000 BP. According to the original source, dates of *c.* 18 000-20 400 BP at the Liyuzui site were obtained from *below the cultural layer* (Radiocarbon Dates 1991: 217). The significantly younger ^{14}C date determined from human bone, $11\,450 \pm 150$ BP (PV-0402) (Radiocarbon Dates 1991), is associated with pottery at this site (Zhang 2000). Thus, Yasuda's attempt to 'revive' these very old values without critical evaluation contradicts the 'chronometric hygiene', and does not allow their incorporation into our dataset. Finally, Yasuda (2002: 123, Fig. 6) mistakenly presents a photograph of the Bailiandong site cross-section instead of one showing Liyuzui, which might confuse readers because the dates shown in the figure are not those from Liyuzui but from Bailiandong.

A new ^{14}C date from the Hutouliang site in Hebei Province of northern China, $13\,080 \pm 200$ BP (GrA-10460) (Yasuda 2002: 127), produced on unidentified material and without details of the association of date and pottery, should not be accepted until more information is provided. No details about the association of pottery and this ^{14}C date have been given so far (Guo & Li 2002). Previously, the date of *c.* 10 700 BP at this site was associated with the Final Palaeolithic complex without any pottery (Radiocarbon Dates 1991). In my opinion, the earliest pottery-associated ^{14}C date from northern China is $10\,210 \pm 110$ BP (BK87075) (12 600-11 300 cal BP) from the Nanzhuangtou site (Figure 2).

Japan

Since the 1960s, when the number of ^{14}C -dated prehistoric sites was quite small (e.g. Morlan 1967), significant progress in ^{14}C dating of the earliest pottery sites, corresponding to the Incipient Jomon phase, has been made. There are currently at least 80 known Incipient Jomon sites in Japan (Jomon Jidai Sosoki Shiryoshu 1996), and ten of them have ^{14}C dates older than *c.* 11 000 BP (Figure 1) (see details in Keally *et al.* 2003, 2004). Up to now, Japan has provided the most abundant records of the earliest pottery in East Asia, with more than 100 associated ^{14}C dates on wood, charcoal and food residues (e.g. Keally *et al.* 2003). Nevertheless, most of this dataset was not included even in the most recent book on Jomon archaeology (Habu 2004: 26-42).

It is evident that the earliest pottery in Japan is dated to at least *c.* 13 500 BP (*c.* 16 800-15 600 cal BP, and probably up to *c.* 17 200 cal BP) (Nakamura *et al.* 2001) (Figure 2). The very early date of $16\,250 \pm 180$ BP (NUTA-1515), previously associated with pottery at the Shimomouchi site (Kajiwara 1998; Yasuda 2002: 123), is now rejected due to two factors: a) ambiguous association of ^{14}C -dated charcoal and pottery and b) inconsistency compared with the general chronological sequence of the Japanese Palaeolithic and Incipient Jomon (Ono *et al.* 2002; see also Habu 2004: 36-7).

Naumann (2000: 1-2) challenged the reliability of the earliest Jomon ^{14}C dates due to volcanic activity on Japanese Islands and distortion of ^{14}C ages by 'old carbon' emission from

volcanoes. However, the ^{14}C dating of tree rings shows a good agreement of results with internationally accepted calibration curves, thus no significant contribution of the 'dead' carbon from volcanic emission was detected in Japan (e.g. Imamura *et al.* 1999). Therefore, Japanese ^{14}C dates seem to be reliable, including the earliest pottery-associated values.

Russian Far East

The first Final Pleistocene ^{14}C date associated with pottery in the southern Russian Far East came to light in the early 1980s. In the 1990s and early 2000s, more dates older than *c.* 10 000 BP were obtained from the Initial Neolithic sites of Gasya, Khummi, Gromatukha, Goncharka 1, and Novopetrovka 2, all with pottery (Kuzmin 2002; Kuzmin & Orlova 2000; Kuzmin *et al.* 1997; Derevianko *et al.* 2004) (Figure 1). The charcoal ^{14}C values are the most reliable ones because they are generally directly associated with human activity. These show clearly that the earliest pottery in the Russian Far East is dated to *c.* 13 300–12 300 BP (16 500–14 100 cal BP) (Figure 2).

These dates correspond well to the chronological sequence of the Palaeolithic-Neolithic transition. However, sometimes much older dates were obtained from layers presumed to contain pottery. At the Khummi site, one of the charcoal ^{14}C dates is $42\,800 \pm 1900$ BP (AA-13394) (Kuzmin *et al.* 1997: 496). The lack of any artefacts near the place where the dated charcoal was collected allow us to reject this value. Another charcoal sample from dwelling 1 at Khummi returned a ^{14}C date of $23\,160 \pm 210$ BP (AA-23129) and this is also rejected. Perhaps the natural pieces of charcoal in bedrock colluvial deposits at Khummi, originating from forest fires, were later incorporated into cultural layer and so gave anomalous ^{14}C ages.

The compression of prehistoric cultural layers in the Russian Far East is a common feature. In order to avoid any possible age distortion from the 'palimpsest' stratigraphy at the key sites, attempts to date the plant-fibre-tempered pottery directly have been conducted (O'Malley *et al.* 1999; Derevianko *et al.* 2004). According to these, the manufacture of pottery with organic temper in the Russian Far East may have started as early as *c.* 13 300–12 700 BP, and continued until *c.* 7300 BP.

Naumann (2000: 49) mistakenly associated the ^{14}C value of $12\,960 \pm 120$ BP (LE-1781) on the Gasya site with the Ustinovka 3 site. Furthermore, the association of the ^{14}C date of $11\,500 \pm 100$ BP (SOAN-1552) and pottery at the Ust' Kjachta (another spelling is Ust-Kyakhta) site in Transbaikalia, southern Siberia, is vague (Kuzmin & Orlova 2000: 359). Thus, the assumption of the emergence of pottery in Siberia and its spread to the Amur River basin and further to Japan (Naumann 2000: 49) appears to be unreliable.

Korea

The general understanding of the age of the earliest pottery in Korea until recently was that it began at *c.* 7100 BP (Choe & Bale 2002). The possible extension of the beginning of the Bissalmuneui (Neolithic in the sense of this review) period with pottery to *c.* 12 000 BP was rejected because of the ambiguous association of the earliest Osanni site ^{14}C value, *c.* 12 000 BP, with the pottery (Choe & Bale 2002: 96). The fact that the rest of the

Osanni Neolithic dates are within *c.* 7100–4400 BP, makes the 12 000 BP date less reliable. According to the ‘chronometric hygiene’ principal and general chronological patterns of the Korean Neolithic, I also reject this date.

Since the mid-1990s, the Kosan-ni site on Cheju Island off the mainland Korean Peninsula (Figure 1) has been considered as one of the earliest pottery complexes with a possible age of *c.* 10 000 BP (e.g. Im 1995). The pottery from the lower component of Kosan-ni is tempered with organic matter such as grass and/or dung (L.N. Mylnikova pers. comm. 1999). However, until 2000, no ¹⁴C dates were obtained, partly due to the lack of charcoal at the site (C.H. Kang pers. comm. 2002). Two ¹⁴C datasets were received after direct dating of this pottery (Bae & Kim 2003). Low temperature oxygen combustion of two samples gave very different ages, 10 180 ± 65 BP (AA-38105) and 4480 ± 45 BP (AA-38106). The alkali extraction method gave two quite late ¹⁴C values, 6910 ± 60 BP (SNU02-584) and 6230 ± 320 BP (SNU02-096), compared with an expected Final Pleistocene or Earliest Holocene age. It is clear that additional dating of the Kosan-ni site is required.

Where were the centres of the first pottery in East Asia?

Did pottery originate in one place and spread to neighbouring regions afterwards, or did it emerge in different places at the same time and independently? In the prehistory of East Asia we have examples of technologies with both single and multiple origins. The origin of rice agriculture in the Yangtze River basin and the spread from its initial core to Southeast Asia and other regions, such as Korea and Japan (e.g. Higham & Lu 1998), exemplifies diffusion from a single centre of origin. As an example of independent invention, the extensive exploitation of marine mollusc resources in the Initial Jomon of Japan since *c.* 9500 BP may be referred to. It appeared almost simultaneously with shellfish exploitation in Europe and the Americas. In my opinion, chronological information should be used in conjunction with data about the earliest pottery types (shape and mode of manufacture) in East Asia to find out where pottery originated at the end of the Pleistocene. According to critical examination of the earliest ¹⁴C dates associated with pottery, manufacture began in China at *c.* 13 700–13 300 BP, in Japan at *c.* 13 500 BP (and possibly as early as *c.* 13 800 BP), and in the Russian Far East at *c.* 13 300 BP. It is obvious that this was an almost simultaneous appearance of the new technology in different parts of East Asia, separated from each other by several thousand kilometres.

Pottery designs, shapes, and some technological characteristics for these three regions are quite different. In southern China, two types of pottery were found at the Yuchanyan site, with thick walls (up to 2.0cm), round bases, inorganic temper of coarse grains of quartzite (Zhang 1999, 2002a), and cord marks (Zhao & Wu 2000: 234). Pottery from the Xianrendong site is characterised by thick walls (up to 1.2cm), round bases, and inorganic temper (Zhang 1999, 2002a). The surfaces of the vessels are either plain or have streak marks. The earliest Incipient Jomon pottery in Japan (phase 1 in Keally *et al.* 2003) is mostly plain ware; few vessels have impressed or incised marks. Some pottery has fibre tempering, although this is not typical. Most of the pottery is round-based; some pots have flat bases. Phase 2 pottery belongs mainly to the linear-relief type, with bean-relief on some of it. The shapes of vessels vary somewhat, and both pointed and flat bases occur. Generally,

Incipient Jomon pottery is quite thin (less than 1cm) (Jomon Jidai Sosoki Shirayoshi 1996). The earliest far eastern Russian pottery from Osipovka (Gasya and Khummi sites) and the Gromatukha complexes has flat bases and is fibre-tempered, with thick walls (up to 1.7cm) and almost no surface decoration (e.g. Kuzmin 2002). Only at the Goncharka 1 site were comb marks, zigzag lines, and cord impressions observed on the vessel surfaces (Kuzmin & Shewkomud 2003).

Thus, very different pottery types (e.g. Keally *et al.* 2004: 349; but see Vandiver 1999) appeared simultaneously at several places within greater East Asia at about the same time. Until now, there is no well-documented scientific evidence of human exchange and/or migrations between these areas in the Late Glacial. The attempt to correlate the earliest pottery from southern China (Xian phase, MacNeish *et al.* 1998) with pottery from the Ustinovka 3 site in Primorye (Russian Far East) and Miyagase site in Japan is inconsistent. Ustinovka 3 is much younger than the Xian phase, *c.* 9300 BP versus *c.* 13 500-11 800 BP, and the Miyagase site has no reliable ¹⁴C data. Another attempt to find joint features in the earliest pottery from Japan and the Russian Far East, made by Kajiwarra (1998), also failed to provide reliable evidence (Keally *et al.* 2003: 10-1). This, in my opinion, means that there were at least three independent 'centres' of pottery origin, located in southern China, Japan, and the Russian Far East.

Conclusion

The critical assessment of early ¹⁴C dates for pottery manufacture has resulted in the elimination of a number of doubtful values, and the surviving acceptable dates are listed in the text. We can conclude that the earliest technology for making food containers of fired clay appeared in East Asia concurrently in three separate regions, southern China, the Japanese Islands, and the Russian Far East, during the Late Glacial, *c.* 13 700-13 300 BP (*c.* 17 300-15 000 cal BP; Figure 2). The first pottery coincided with conditions of gradual climatic warming after the Last Glacial Maximum, with the re-appearance of deciduous trees within the conifer formations of the northern regions (Amur River basin and northern Honshu), and the replacement of conifer forests with deciduous ones in southern territories (central and southern Honshu; Kyushu and Shikoku; lower stream of the Yangtze River).

A number of problems and pitfalls were encountered with the ¹⁴C dating. In many cases the pottery itself contained no organic datable material, and the dates relied on association with other materials related to human occupation, particularly bone and charcoal. In some cases the association was unclear, and the dateable material was, or may have been, residual. In other cases the charcoal derived from natural sources in Quaternary sediments, giving spurious dates. Nevertheless, ¹⁴C dates from charcoal appear currently to offer the most reliable age estimates of the earliest pottery-making sites in East Asia.

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