# RADIOCARBON DATING OF THE EARLIEST NEOLITHIC CULTURES FROM THE RUSSIAN FAR EAST:

## INITIAL RESULTS BASED ON ACCELERATOR MASS SPECTROMETRIC(AMS) DATING OF ORGANIC TEMPER IN POTTERY

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## ABSTRACT

The extraction of carbon from temper in organic-tempered pottery of the Initial Neolithic sites on the Russian Far East allowed to date directly the earliest pottery in the area. First results show that pottery of the Gromatukha culture has $^{14}C$ ages ca. 13,300-10,400 BP, and the Novopetrovka culture pottery is much younger, with $^{14}C$ age of ca. 9800 BP. In the Primorye, the earliest pottery was $^{14}C$ dated to ca. 10,700 BP. Today, the Middle and Lower Amur River basin have evidence of very early pottery manufacture, started ca. 13,000 BP.

## Introduction and Background

The emergence of pottery in East Asia always means the beginning of the Neolithic (e. g., Chard, 1974; Barnes, 1993; etc.). Prior to the late 1970s, the only place in the world with Incipient Neolithic sites, dated to ca.12,900-12,500 radiocarbon ($^{14}C$) years ago [BP], was Japan (Morlan, 1967; Aikens, Higuchi, 1982). In the early 1980s, newly released $^{14}C$ dates from both Southern China and the Russian Far East suggested the appearance of very early pottery in these territories, ca. 13,000-11,000 BP (Okladnikov, Medvedev, 1983; Ho, 1984; Chang, 1986). However, the small number of $^{14}C$ dates (about 10-15 determinations) on charcoal associated with the pottery made this suggestion speculative.

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In the 1980s-1990s, significant progress was made in both excavation and $^{14}C$ dating of the earliest Neolithic cultures in continental East Asia, including Northern and Southern China (Chang, 1986; Nelson, 1995; MacNeish, Libby, 1995), and the Amur River basin, Russian Far East (Krushanov, 1989; Kuzmin *et al.*, 1997, 1998; Shevkomud, 1997). Today, we have about 25-30 $^{14}C$ dates older than 10,000 BP and about 40-50 $^{14}C$ dates from 10,000 to 8,000 BP, made on charcoal associated with the earliest pottery in East Asia.

The emergence of pottery caused major changes in human paleoeconomy from a mostly hunter-gatherer's nomadic subsistence to a more settled lifestyle with the emergence and/or further development of fishing. Also, in general the pottery invention closely corresponds to the beginning of agriculture. In East Asia the human-environment interaction in the terminal Pleistocene and in Early-Middle Holocene, ca. 15,000-6000 BP, was very complex. Dryland agriculture was developed in East Asia from ca. 7,000-8,000 BP, much later than the beginning of pottery-making. Diversity of cultural development is very important problem for the archaeology of the whole Old World, and we should pay particular attention to the timing of the emergence of such important cultural innovations as pottery and agriculture.

Another very important problem is the timing of the emergence of pottery in different parts of East Asia. Significant progress has been achieved in the last 15-20 years in the $^{14}C$ dating of the earliest Neolithic cultures in China (Chang, 1986, 1992; Nelson, 1995), Korea (Nelson, 1993), and the Russian Far East (Kuzmin *et al.*, 1994, 1997, 1998). The correlation of cultural processes in both continental and insular East Asia based on $^{14}C$ data is crucial to create a model of pottery spreading from the core areas toward marginal territories.

Nevertheless, the problem of the stratigraphic association of charcoal and pottery still remains. At most of the earliest Neolithic sites in the Russian Far East, we have compression of cultural material of different stages in one layer, including sometimes tools and pottery of the earliest Neolithic along with the younger artifacts, which belong to the Late Neolithic, and Bronze and Early Iron Ages. Another problem is the difference in age between the charcoal samples even for the homogenous-like Initial Neolithic layer because of the compression and mixing of the cultural material. In some cases, the difference may be up to 2,000-3,000 $^{14}C$ years and even more (cf., Kuzmin *et al.*, 1997). Thus, direct $^{14}C$ dating of pottery is crucial for the construction of reliable chronology of the earliest Neolithic cultures in the Russian Far East and in the whole East Asia.

Earliest Japanese pottery from the Incipient and Initial Jomon sites (ca. 12,700-6000 BP) do not contain any organic temper (Aikens, 1995). However, on continental East Asia, the oldest pottery technology was based on clay tempering with organics. In the Russian Far East, all the earliest Neolithic pottery was plant-fibre tempered (Zhushchikhovskaya, 1997). Similarly, recent excavations in southern China (MacNeish, Libby, 1995) revealed that the X'ian-phase pottery contained organic inclusions, and pottery-associated charcoal was $^{14}C$ dated to ca. 14,000-11,000 BP.

Since the 1960s, several attempts to date the organic matter from archaeological pottery using radiocarbon were made by liquid scintillation counting (LSC) (see review in De Atley, 1980). The amount of carbon required for LSC, at least 3 g of carbon after pretreatment, limits the accuracy of measurements, because of possible contamination of carbon from temper and food residues by <old> carbon from clay during pottery combustion. The <old> carbon from clay usually does not corresponds to the time of pottery manufacture and usage, and the age determinations for such samples are older than the dates made on pottery-associated charcoal. The development of $^{14}C$ Accelerator Mass Spectrometer (AMS) technique in the late 1970s made it possible to measure the $^{14}C$ content for very small samples, with amount of total carbon of 0.2-0.5 milligram carbon (e. g., Donahue, 1995). Nevertheless, there is not much consistency in the first results of direct $^{14}C$ AMS dating of the pottery (cf., Hedges *et al.*, 1992; Delque Kolic, 1995). The latest achievement in sample treatment for carbon extraction and direct $^{14}C$ dating of pottery was made by E. Delque Kolic (1995). She concluded that low-temperature combustion in and oxygen-enriched atmosphere allowed the extraction of carbon which mostly from the human-related sources such as temper, smoke, and soot, and that there was a minimal release of <old> carbon from the clay.

During the last years, extensive geoarchaeological study of the Neolithic cultures on the Russian Far East was conducted (Kuzmin, 1994; Kuzmin *et al.*, 1994, 1997, 1998; Kuzmin, Jull, 1997; Jull *et al.*, 1994). In 1996, direct $^{14}C$ AMS dating of pottery from the Russian Far East was began at the NSF-Arizona AMS Facility, University of Arizona, USA, and continued this research in 1997. This paper focuses on the first results of direct radiocarbon accelerator mass spectrometry (AMS) dating of the oldest pottery from the Russian Far East. It based on several papers and abstracts (Jull *et al.*,1998; O'Malley *et al.*, 1998, in press), both published and submitted for publication.

## Material and Methods

Several Initial Neolithic sites with organic-tempered pottery were selected, Gasya of the Osipovka culture (Derevianko, Medvedev, 1995); Ust-Ulma (layer 1) of final stage of the Selemdzhinskaya culture (Derevianko, Zenin, 1995); Chernigovka (Zhushchikhovskaya, 1997); Novopetrovka (Derevianko, 1970); and Gromatukha (Okladnikov, Derevianko, 1977) (Fig. 1).

The method of pottery treatment was previously described (O'Malley *et al.*, 1998, in press). We used the AMS technique to study the individual carbon components of our early Far Eastern Russian pottery samples. In total, seven pottery samples from five sites were studied (Table 1). We initially measured radiocarbon ages on bulk samples (Jull *et al.*, 1998). These were pretreated with a standard acid-alkali-acid (AAA) pretreatment and then combusted on a vacuum line with CuO at approximately 1000℃ for 10 minutes. The samples were then divided into exterior and interior subsamples. We expected that the interior portions of the pottery would be relatively rich in temper, as compared with the exterior portions. Temper is the organic material which

### Table 1

Radiocarbon AMS dates of the pottery temper from the Russian Far East Initial Neolithic sites (interior part of sherds, 400℃, oxygen combustion)

| Site name, layer | AA # | Lab # | Radiocarbon date, BP |
|---|---|---|---|
| Gasya* | 20934 | Z282A | 9020+65 |
| Ust-Ulma* | 20935 | T6886 | 8900+90 |
| Chernigovka | 20936 | Z286A | 10770+75 |
| Novopetrovka | 20937 | Z288A | 9765+70 |
| Novopetrovka (Gromatukha layer) | 20938 | Z290A | 10400+70 |
| Gromatukha | 20939 | Z282A | 13240+85 |
| Gromatukha | 20940 | Z294A | 13310+110 |

* The combustion was made with CuO

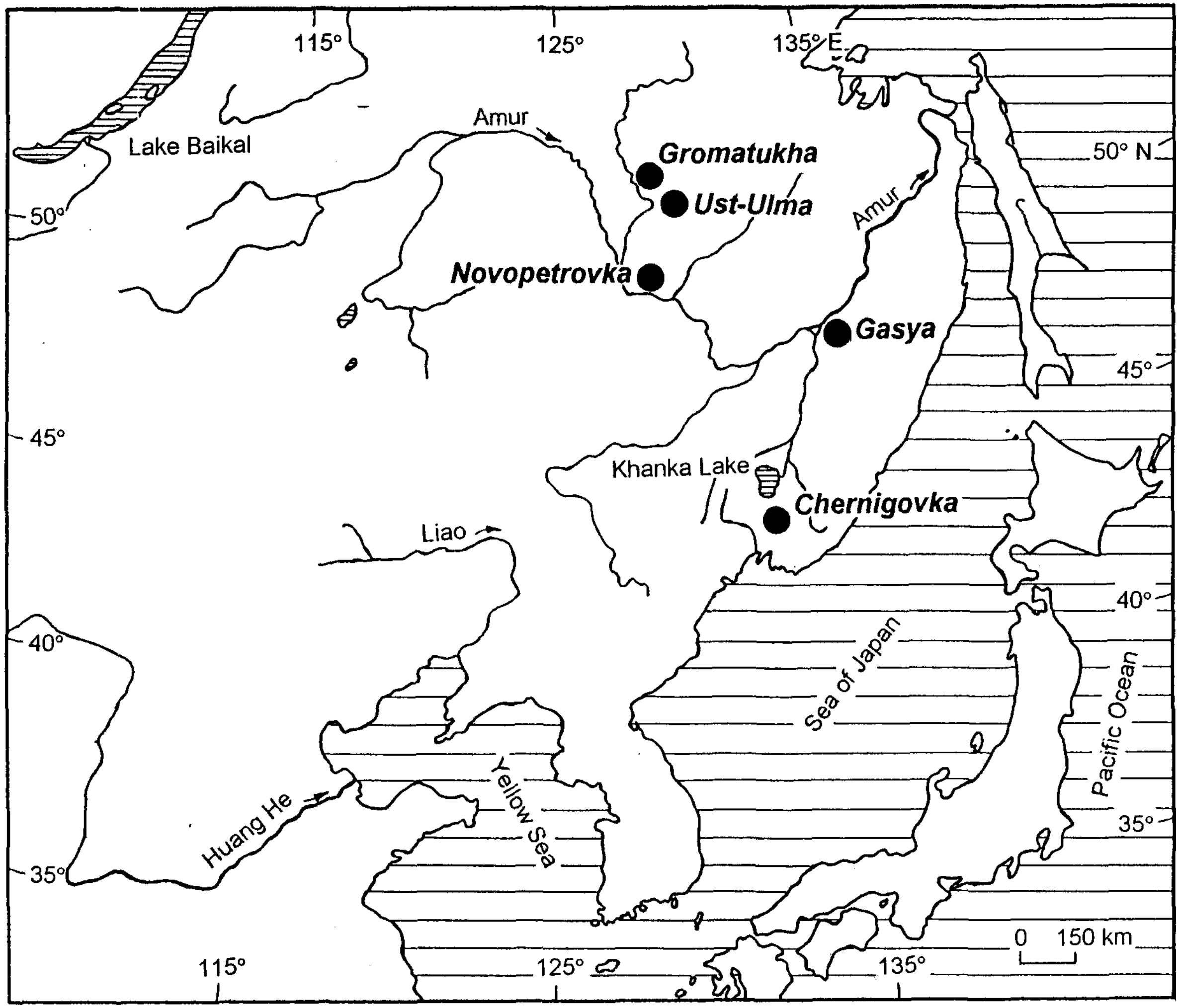


Fig. 1 Location of the Initial Neolithic sites on the Russian Far East, with pottery directly dated by $^{14}C$ AMS method

is mixed with the clay to fire the pottery. In some of our samples it was possible to see plant material within the clay matrix, however, these organics were so tightly bound with the clay that we could not physically separate them from the clay. We also hypothesized that the interior portions of the samples were relatively free from contamination.

We sampled the shards by scraping off fine flakes and powder from the exterior surfaces, and then sampled from the middle or interior portion of the shard. Both fractions were pretreated with the standard AAA technique. The first fractions were packed in 9mm quartz tubes and combusted with CuO. These were placed on a vacuum line, evacuated and combusted with a furnace at 400℃ for one hour. The carbon gas was then extracted and the sample was combusted again at 800℃ for 30 minutes. The sample tube was not removed from the vacuum apparatus between extractions. The remaining samples were combusted using the same type of vacuum line and controlled temperature combustions, but with oxygen gas as an oxidant rather than CuO.

## Results and Discussion

In total, 45 $^{14}C$ values were obtained (Jull *et al.*, 1998; O'Malley *et al.*, 1998, in press). In reviewing the data three observations can be made; 1) the $^{14}C$ ages of the 800℃ fractions are almost always older than those of the 400℃ fractions; 2) the $^{14}C$ ages of the interior subsamples of the shards are generally older than the ages of the exterior portion of the shards; and 3) the percent carbon yield for the combustion of our pottery is higher at 400℃ with oxygen, while a similar yield is only obtained at 800℃ using CuO.

From the study of the direct AMS dating of pottery one can conclude that *the low temperature fraction (400℃) on the carbon-rich portions of pottery, combusted with oxygen, presently provides our best estimate of the age of the ceramics*. However, more studies need to be done in order to improve the carbon extraction techniques from such complex sources, and especially to reduce and refine the combustion temperature limits where possible.

The Gasya and Ust-Ulma sites were treated so far only with CuO combustion (Table 1). Thus, the $^{14}C$ ages, ca. 9,000 and 8,900 BP, may be considered as provisional. The charcoal $^{14}C$ dates from the Gasya site range from ca. 13,000 BP to 10,900 BP (Kuzmin *et al.*, 1997). The earliest pottery from Primorye, found on Chernigovka site

(Zhushchikhovskaya, 1997), was dated to ca. 10,800 BP. Taking into consideration the result of optical-stimulated luminescence (OSL) dating of the pottery from Ustinovka 3 site, 10,500 yr ago [calendric years !] (Shevkomud, 1997; Garkovik, 1998), which corresponds to ca. 9,500 $^{14}C$ years BP, we agree with Zhushchikhovskaya's (1997) suggestion.

The most important implication of direct $^{14}C$ AMS dating of pottery is the first $^{14}C$ values for two key sites, Gromatukha and Novopetrovka. The Gromatukha pottery yielded $^{14}C$ age between ca. 13,300 and 10,400 BP, and Novopetrovka pottery has one age determination, ca. 9,800 BP. A. P. Derevianko and V. T. Petrin (1995) archaeologically dated the Novopetrovka culture as ca. 10,000 BP, and Gromatukha culture as ca. 10,000-7,000 BP. Our data allow to assume that Gromatukha pottery is significantly older than Novopetrovka one.

## Conclusion

First data set of $^{14}C$ AMS dating of organic-tempered pottery from the Russian Far East confirm that the earliest pottery appeared ca. 13,000 BP in the middle and lower streams of the Amur River, and belongs to the Osipovka and Gromatukha cultures. In Primorye, the pottery appeared much later, ca. 10,700-9,500 BP. The first results of direct dating of pottery show that Gromatukha culture might be older than Novopetrovka. To make more solid conclusion, more pottery and charcoal should be dated. So far, there are two cultures on the Russian Far East, Osipovka and Gromatukha, with $^{14}C$ dates of charcoal and pottery about 13,000-10,400 BP. This show quite clear that both middle and lower streams of the Amur River have evidence of very early beginning of pottery-making, ca. 13,000 BP.

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