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# Pottery use by early Holocene hunter-gatherers of the Korean peninsula closely linked with the exploitation of marine resources

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ABSTRACT

The earliest pottery on the Korean peninsula dates to the early Holocene, notably later than other regions of East Asia, such as Japan, the Russian Far East and Southern China. To shed light on the function of such early Korean pottery and to understand the motivations for its adoption, organic residue analysis was conducted on pottery sherds and adhered surface deposit on the wall of pottery vessels (foodcrusts) excavated from the Sejuk shell midden (7.7–6.8ka calBP) on the southeastern coast and the Jukbyeon-ri site (7.9–6.9ka calBP) on the eastern coast of the Korean peninsula, that represents the earliest pottery assemblages with reliable radiocarbon dates. Through chemical and isotopic residue analysis, we conclude that the use of pottery at these sites was oriented towards marine resources, supported by lipid biomarkers typical of aquatic organisms and stable carbon isotope values that matched authentic marine reference fats. The findings contrast with other archaeological evidence, which shows that a wider range of available food resources were exploited. Therefore, we conclude pottery was used selectively for processing aquatic organisms perhaps including the rendering of aquatic oils for storage. Early pottery use in Korea is broadly similar to other prehistoric temperate hunter-gatherers, such as in Japan, northern Europe and northern America. However, it is also notable that elaborately decorated red burnished pottery excavated from isolated location at the Jukbyeon-ri site had a different usage pattern, which indicates that division of pottery use by vessel form was established even at this early stage.


## 1. Introduction

In East Asia, multiple and separate origins for pottery have been proposed, including southern China, Russian Far East and the Japanese archipelago (Keally et al., 2004), all dating to the Pleistocene and therefore significantly prior to ceramic production in any other part of the world (Jordan et al., 2016). Within this context, the Korean peninsula is notable for the later arrival of pottery which appeared only at the end of the early Holocene (Choe and Bale, 2002), at around the 6th millennium BC, presumably via cultural transmission from one or more of these other regions. To shed light on the function of such early Korean pottery and to understand the motivations for its adoption, here we present the results of chemical and isotopic analysis to determine vessels contents. More specifically, we examine whether pottery had a general function and therefore dispersed as an 'adaptive' technology or a more restricted range of uses and therefore as a more specialized technology. The latter has been suggested for late Pleistocene ceramic vessels (Craig et al., 2013; Lucquin et al., 2016a) reflecting motivations for pottery innovation. Therefore it is important to know whether a relaxing of function aided the later dispersal of ceramic technology to new regions as some have hypothesised (Jordan and Zvelebil, 2009) or whether early pottery in Korea follows the same pattern as other parts of East Asia. (see Table 1)

The Korean Neolithic (or *Chulmun* named after the pottery type name) is defined by the appearance of pottery (Kim, 1986). Unlike the Western Neolithic complex, this key innovation is not synchronous with the appearance of domesticated plants and animals, sedentism or even polished stone tools. Animal husbandry in this area started much later, during the second half of the first

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millennium BC (Lee, 2013). Domesticated plants appeared in the 4th millennium BC (Crawford and Lee, 2003), represented by two types of millet—foxtail (*Setaria italica* ssp. *italica*) and broomcorn (*Panicum miliaceum*), accompanied with azuki bean (*Vigna angularis*) and soybean (*Glycine max*) (Lee, 2011). Recent analysis of seed impressions left imprinted on pottery vessels during their manufacture has tentatively suggested that millet may have been introduced as early as the Initial Chulmun (Obata and Manabe, 2014) and therefore contemporary with the early adoption of pottery. However, the date of these vessels is disputed on typological grounds with the growing suspicion that they belong to the Middle to Late Chulmun (Kim, 2016). So far there is no conclusive evidence showing that the adoption of pottery is in anyway linked to the introduction of crop cultivation in this part of the world.

Previously, Korean pottery was thought to be dated to as early as 11 k calBP based on the typological comparison of the vessels from Gosan-ri on Jeju island, 50 km south of the peninsula, with well dated Russian and Japanese assemblages (Kang, 2006). However, recent re-dating indicates that this site is in fact much younger; ca. 9.5 k calBP (Jeju Cultural Heritage Institute, 2014). Interestingly, there is a lack of such early Holocene pottery on the Korean peninsula. The earliest securely dated pottery assemblages on the Korean peninsula are *Yunggimun* (clay strip decorated) vessels that appear widely (Fig. 1) from ca. 7.8 to 6.4 k calBP (Initial Chulmun), although pottery has been reported from pre-Yunggimun layers (Busan University Museum, 1994) but their actual date requires confirmation.

As many early pottery sites on the Korean peninsula (Fig. 1) are found in coastal locations, coinciding with the earliest shell middens, a reasonable hypothesis is that pottery was part of a broader maritime adaptation at this time. Sea-level on the east coast of the Korean peninsula stabilized during the period of pottery adoption 8-7ka calBP (Jang and Park, 2001, p.143) which also broadly corresponds to the Holocene climate optimum and the stabilization of oak forests (Park et al., 2012). As a consequence of sea level change, it is quite possible earlier coastal sites, perhaps bearing pottery, are now submerged although the absence of any evidence for pottery even at earlier inland locations implies that the late adoption is a more reasonable interpretation (Lee, 2011).

Stable isotope analysis of human diets also show that the Chulmun hunter-gatherers were heavily dependent on marine resources as a source for their dietary protein, especially individuals buried on the south coast of the Korean peninsula (An, 2006; Choy and Richards, 2010; Choy et al., 2010, 2012; Shin et al., 2013). However, this technique is insensitive to low protein plant foods, unless they are consumed in great quantity and the analysis of the faunal and botanical remains from these sites generally show that broad spectrum of food resources was exploited despite the coastal settings (Ahn et al., 2007). In any case, neither the faunal remains nor stable isotope data necessarily relate to the use of pottery, especially if used highly selectively. The most promising approach to reveal pottery contents, and thus direct insight into the motivation for its adoption, is through organic residue analysis. While this technique has been applied widely to early pottery assemblages in East Asia (Craig et al., 2013; Lucquin et al., 2016a), much less attention has been paid in Korea with only three studies of much later prehistoric material so far undertaken (Kwak and Marwick, 2015; Heron et al.,2016a; Kwak et al., 2017).

Here we targeted both ceramic matrices and adhering surface deposits (hereafter foodcrust) from the Sejuk shell midden site on the southeast coast and the Jukbyeon-ri site on the east coast of the Korean peninsula, dated to ca. 7.7–6.8 k calBP and 7.6–6.9 k calBP, respectively. Pottery from these sites represent the earliest examples on the Korean peninsula. Moreover, the geographical location (Fig. 1) and nature of the sites, i.e shell midden vs. open site, provide a basis to examine the variability of the earliest pottery phases for this region.

## 2. Materials

### 2.1. The Sejuk shell midden

Sejuk, one of the earliest known shell midden sites in Korea, is located at an inner bay on the southeast coast of the Korean peninsula (Fig. 1); 35°27′50″N, 129°21′15″E. An area of approximately 10,000 square metres was excavated in 2000. The stratigraphy was established which divides the midden into three cultural layers. However, the evidence from pottery typology and radiocarbon dates show that the materials were deposited very quickly and probably belonged to a continuous singular phase (Ahn et al., 2007).

A large amount of ecofacts have been recovered from this site supporting a broad subsistence base. Seed and fruit remains are represented by wild fruits such as *Acitinidia*, *Rubus* and *Vitis*, nuts like *Quercus* and *Styrax*. Animal remains are represented both by the terrestrial and aquatic remains. These include terrestrial (*Sus scrofa*, *Cervus nippon hortulorum*, *Hydropotes inermis*) and sea mammals (*Zalophus californianus japonicus*), birds (*Gavia* sp., *Phalacrocorax filamentosus* and *Phalacrocorax pelagicus*), marine fish

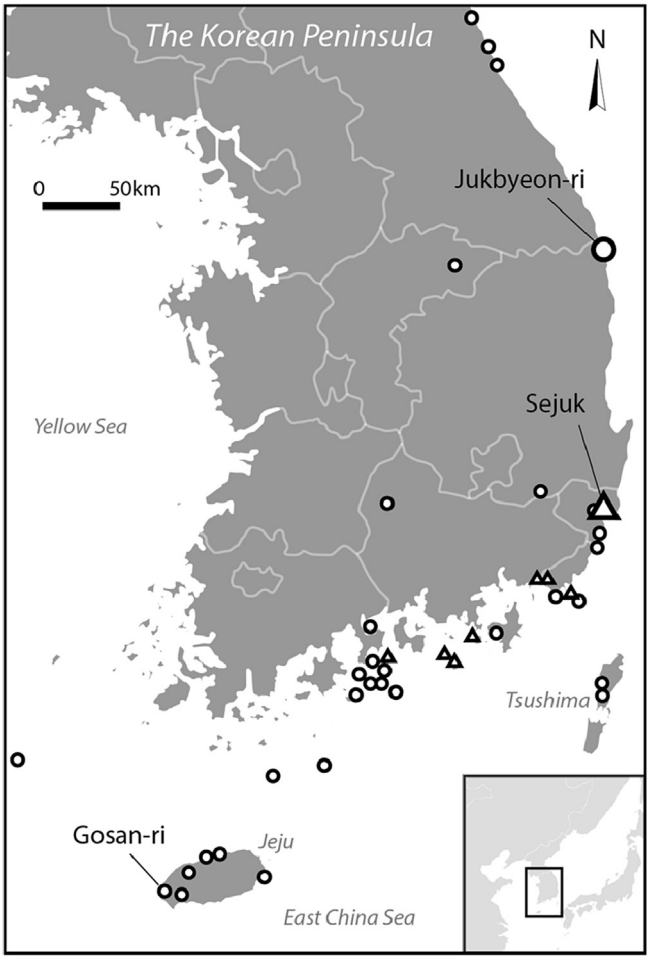


**Fig. 1.** A map showing the distribution of Yunggimun style and earlier pottery on and around the Korean peninsula, indicating the locations of some sites mentioned in this paper. Triangles - shell midden sites, Circles - open sites. Adapted from Dongsamdong shell midden museum, 2004.