The adoption of pottery into the New World

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CHAPTER 8

General conclusions

The central aim of this research was to improve our understanding of the adoption of pottery technology into the New World, more specifically, among Subarctic hunter-gatherer groups in Southwest Alaska, and to evaluate the evolution of these artefacts throughout time, with respect to function. The main research question addressed in this thesis was: **"What drove the adoption of pottery into Subarctic Southwest Alaska?"**. The main topic was addressed by posing sub questions. What was pottery used for? And how does the function of pottery relate to the function of other durable (rival) technologies, such as stone bowls? Why was pottery adopted with such a significant delay on Kodiak Island? Why was it adopted in the southern archipelago, but rejected in the north by people of the same culture?

This doctoral project has focused on these themes (i.e., pottery adoption and function) in the setting of Subarctic Alaska. In the (sub)Arctic, the manufacture and maintenance of durable container technologies is even more costly than in other, more temperate climates (Jordan and Gibbs, 2019). Here, at its extreme margin, the end point of a series of major dispersal events of pottery technology originating in Northeast Asia, key issues concerning the reasons for the adoption of pottery are brought into sharp focus, making it an ideal setting in which to investigate the reasons for pottery adoption by non-sedentary, non-agricultural societies in high-latitude environments.

To investigate, an extensive and critical review of the existing literature on the research context was undertaken. This resulted in a chapter (Admiraal and Knecht, 2019) on

Southwest Alaskan container technologies in a recently published book by Cambridge University Press (Jordan and Gibbs, 2019). In this chapter (co-authored by Dr. Rick Knecht), I presented a critical review of the culture history of Southwest Alaska, and discussed the appearance of pottery, stone vessels and griddle stones in the area. It became clear that durable Alaskan container technologies are a neglected artefact category that has gained very little attention throughout the history of the discipline. Very little was published on Aleutian stone bowls and griddle stones (Solazzo and Erhardt, 2007; Jeanotte et al., 2012). Information on early pottery in Alaska was limited to the work of only a few authors belonging to an older generation of research, leaving the state of knowledge parked in 1982 (Ackerman, 1982; Dumond, 1969; Heizer, 1949), with the exception of the work of Anderson et al. (2011) and Harry and Frink (2009).

The chapter reflects the starting point of the research project. It defined gaps in knowledge and led to the formulation of new research questions. It was concluded that in order to understand the drivers of the adoption and use-trajectory of durable container technologies in Alaska, we need to understand the function of these artefacts. Organic residue analysis was chosen as the ideal method to test this. The methodology is reviewed in chapter 3, as well as in the Methods sections of the papers presented in chapters 5 to 7. Furthermore, a methodological paper describing experiments carried out for this research is presented in chapter 4.

Aleutian stone bowls and griddle stones

The first case-study concerned the functional analysis of the oldest durable container technologies in Southwest Alaska: stone bowls and griddle stones from the Aleutian Islands. These artefacts appeared much earlier than pottery, which never spread to the Aleutian

Islands, and are therefore treated first. Questions were raised about the function of these vessels and their use trajectory. Were griddle stones and stone bowls rival technologies? Or did they have different functions? And why were stone bowl occurrences suddenly peaking around 3,000 years ago? Not much was known or published about these artefacts at all (Jeanotte et al., 2012; McCartney, 1970; Quimby, 1945). Thick layers of carbonized residues were present on all artefacts, and were collected for analysis at the Museum of the Aleutians with the permission of the Ounalashka Corporation. It was found that while stone bowls were exclusively used for the processing of marine mammal oils, griddle stones were probably used for cooking dishes consisting mainly of sea food but with the possible addition of plant resources, and/or salmonids. We argued that the use of direct heating in the process of rendering fat may have been adopted as a result of a climatic cold spell (i.e., the Neoglacial), which could have made cold-rendering of fat (using seal pokes or other organic storage technologies) more risky, as it is highly dependent on stable temperatures. These results are an make an important contribution to debates about rival container technologies in northern environments (Frink and Harry, 2019; Jordan and Gibbs, 2019), as well as to the general debate of Aleutian Island archaeology. This paper was peer-reviewed and published in a special issue of *Quaternary Research* aimed specifically at Aleutian Island archaeology, and edited by guest editors Bre MacInnes, Ben Fitzhugh, Kirsten Nicolaysen, and Virginia Hatfield (Admiraal et al., 2019a).

The introduction of pottery into Southwest Alaska

Moving forward in time the focus shifts to, what is in many ways the main theme of this thesis: the earliest adoption of pottery in Alaska, at around 2,800 cal BP. From its entry point at the Bering Strait pottery dispersed quickly along Alaska's coastal margin. By about 2,500 cal BP it reached the Alaska Peninsula, an area that had been abandoned by the Arctic Small

Tool tradition some 500 years earlier. As stated before, early pottery in Alaska is a somewhat neglected artefact category with only a few publications, mainly from an earlier generation of scholars, that in general did not elaborate on aspects of the pottery beyond its typology and classification (Ackerman, 1982; Dumond, 1969; Heizer, 1949). However, Ackerman (1982) early-on proposed origins for Alaskan pottery in Northeast Siberia, in a paper that is still very relevant today. Dumond (e.g., 1969; 1981; 2000; 2011; 2016) discussed Alaskan pottery in more detail, in various publications throughout the years. That the origin of Alaskan pottery lies in Northeast Asia is now generally accepted based on the timing of dispersal as well as stylistic similarities. However, the question of how and why pottery spread to Alaska, was never investigated in more detail. What drove the adoption of pottery into this marginal area? What was the function of pottery, and how did it change? It is thought to have been associated with a maritime intensification originating in the Bering Strait region, but this has never been researched. 37 Norton pottery sherds (2,500 - 1,000 cal BP) and 12 Thule pottery sherds (1,000 cal BP - contact period) were tested using organic residue analysis in order to investigate the function and evolution of pottery on the Alaska Peninsula.

In analysing site localities of early pottery occurrences on the Alaska Peninsula it stood out, early in the stage of this research, that pottery nearly always occurs in close proximity to large river systems supporting extensive salmon runs throughout a large part of the year. Indeed, the lipid and isotope results of this research confirm the conjecture that early Alaskan pottery was in fact connected to salmon harvesting practices at these locations. It seems that pottery adoption in Southwest Alaska first occurred at these major fish harvesting sites, and was not connected to a marine intensification (Farrell et al., 2014; Harry and Frink, 2009; Heizer, 1949). Our results are further supported by recently published residue results at the marine-focused Cape Krusenstern site. Here, against all expectations, a riverine (freshwater) focus for both Norton and Thule pottery was apparent (Anderson et al., 2017). This further confirms the riverine character of early Alaskan pottery. However, there are some Norton sites where pottery was used to process marine resources. These sites are in locations where riverine resources are not as rich (e.g., on the Pacific Coast), and reflect an early diversification of pottery function.

We may conclude that pottery was in fact exclusively used for the processing of aquatic resources. The type of resource may vary depending on site locality and associated resource availability and subsistence practices. Interestingly, while the earliest adoption of pottery in Alaska has long been thought to have been a part of a maritime adaptation, our residue results indicate that pottery function only truly shifted towards marine resource processing with the introduction of Thule pottery at 1,000 cal BP. This increased maritime subsistence focus observed in the pottery is further supported by a increasing focus on coastal areas seen in site locations, the introduction of the toggling harpoon, and other tools for open water hunting (e.g., kayaks), as well as a predominance of marine mammal bones in faunal assemblages (Dumond, 2011).

Interestingly, looking back at the Northeast Asia, the source area of Alaskan pottery, we may witness a similar pattern in pottery dispersal. While a coastal route may seem apparent: climbing up from the earliest pottery sites in southeast China, into Japan, Hokkaido and Sakhalin, where pottery was shown to have been used for marine resource processing (Gibbs et al., 2017, Lucquin et al., 2016b), and further up along the coast of the Okhotsk Sea all the way to Alaska (fig. 6.5). In fact, most early (ca. 4,500 cal BP) northern pottery sites are located in the interior, along the Northeast Siberian river systems (e.g., the Lena, Indigirka, Kolyma, Anadyr rivers). More recent dates are found along the coasts. Therefore, we argue that pottery reached Alaska through an interior continental riverine route, following the Amur River to the Baikal Lake region, and using the Lena River as a motorway to disperse northward. Pottery probably had a function related to fish processing, and maintained this use-pattern into the early pottery traditions of Alaska. These results have been presented in a draft paper intended to submit to Proceedings of the National Academy of Sciences (PNAS) in the near future.

Explaining the delayed adoption of pottery on Kodiak Island

The adoption of pottery on Kodiak Island was significantly delayed, and only ever partial. Considering the consistent aquatic nature of pottery function in Alaska (Farrell et al., 2014, Anderson et al., 2017, Solazzo et al., 2008, chapter 5 this volume), this delay, as well as the partial adoption, is peculiar. Kodiak is in fact extremely rich in aquatic resources. The archipelago is home to an abundance of marine wildlife, and its rivers support some of the largest salmon runs in the world. Indeed, for the past 7,000 years the continuous culture history of the archipelago attest to the exploitation of these resources. One would expect pottery, as a specialized aquatic resource processing tool, to be highly attractive in such a setting. Nonetheless, ceramic technology was only adopted during the late prehistoric Koniag stage, some 500 years ago, with a significant (2,000-year) delay, as compared to the neighbouring Alaska Peninsula. Furthermore, it was never universally adopted on the island. It was adopted in the south, but rejected by people of the same culture in the north. This phenomenon is poorly understood, especially considering that Kodiak Island would have been a prime location for the use of pottery, but the technology was still rejected. What were the reasons behind this delayed and partial adoption of pottery technology on Kodiak Island?

The analysis of organic residues from the pottery of Kodiak Island (35 sherds were tested), showed that the vessels were predominantly used for the processing of marine resources (i.e., marine fish or mammals). A few samples, originating at salmon processing camps further inland, presented isotope values consistent with anadromous species. By investigating contextual information about site function and location we were able to elaborate on the reasons for the limited uptake of pottery in the southern half of the island. We suggested a possible connection between the practice of whaling and the presence of pottery, as based on the overlapping distribution of whale bones and pottery sherds. This is in line with a statement by Knecht (1995) stating that Koniag pottery was probably used for the rendering of marine mammal oil, and is supported by ethnohistoric sources (Heizer, 1949). Our lipid results support this hypothesis.

This paper highlights that social boundaries played a significant role in the adoption, spread and rejection of pottery by different groups on the archipelago. Kodiak has a long culture-history of in-situ development with very little influence from outsiders. Only during the Koniag period, when population growth and subsequent stress on resources led to subsistence diversification and social differentiation, did contact with external peoples increase. This is seen in the presence of exotic raw materials as well as in artefact styles, and finally in the adoption of pottery. We argue that the delayed adoption of pottery on Kodiak was due to explicit social choice, based on local traditions, but also due to an increased exposure to the technology in late prehistoric times of increased contact. These same processes were at work in the rejection of pottery technology by northern Koniag groups. Differences in artefact types, the use of raw materials and linguistic differences illustrate an established social boundary between north and south Kodiak Island. This may explain the limited uptake of pottery in the south, combined with a higher focus on whaling in the southeast.

This case study especially illustrates the social processes that take place at the frontier of this particular pottery dispersal event. The spread of pottery technology originating in Northeast Asia, ended with the Kodiak Island delayed adoption. If not for this delay, pottery may possibly have spread further along the Gulf of Alaska where strong cultural connections exist. And possibly even south into British Columbia. Nevertheless, soon (ca. 200 years) after pottery was adopted on Kodiak Island, the colonization of Alaska by the Russians began, and pottery was quickly replaced by their metal counterparts.

Contributions to wider debates on the adoption of pottery by hunter-gatherers

This research forms a considerable contribution to the wider debate of pottery adoption among hunter-gatherer societies. What were the drivers of pottery adoption in these non-agricultural societies? This question has been raised by many authors over the past decade (Craig et al., 2013; Harry and Frink, 2009; Jordan and Gibbs, 2019; Jordan and Zvelebil, 2009; Lucquin et al., 2018), and the answer will differ slightly depending on the region and local subsistence practices. However, over the past decade an interesting pattern has been emerging from organic residue studies on hunter-gatherer pottery across the globe. It has been shown over and over again that early hunter-gatherer pottery was, more often than not, connected to the processing of aquatic resources (Anderson et al., 2017; Colonese et al., 2014; Heron et al., 2015; Horiuchi et al., 2015; Lucquin et al., 2018, 2016; Meadows et al. 2018; Oras et al., 2017; Shoda et al., 2017).

Northeast Asian origins

By viewing the Alaskan ceramic trajectory from a Northeast Asian perspective, patterns have emerged that otherwise may have remained hidden. The data presented in this research reflect that patterns of early pottery use in Southwest Alaska are not linked to maritime intensification (as might be expected). Instead early pottery in Alaska seems to originate in a riverine adaptation extending back into the continental Neolithic of Northeast Asia. This trend continues into Alaska where pottery appears along rivers, almost without exception, also coastal sites are in fact often situated by river mouths. While maritime adaptations may have played a role in the transferral of pottery from one side of the Bering Strait to the other, this research has shown that its role may not have been quite as vital as previously believed. Marine resource processing only became more prominent in Southwest Alaska with the introduction of the Thule tradition at around 1,000 cal BP. From a more global perspective, this research forms yet another example of the specialized aquatic function of hunter-gatherer pottery. Building on other evidence from Eurasia a clear pattern emerges, unmistakably connecting the rise of pottery technology to the processing of aquatic resources.

The data presented in this PhD research further confirms this trend, and refines it. Early pottery in Alaska, at the very end of the technology's dispersal route that originated in Northeast Asia, was also used to process aquatic resources. As said, this is in line with residue research from the origin region, where pottery from Japan (Horiuchi et al., 2015; Lucquin et al., 2016b, 2018), Korea (Shoda et al., 2017) the lower Amur, and Hokkaido-Sakhalin Island (Gibbs et al., 2017) have consistently yielded aquatic lipid result. This thesis represents the first systematic, large-scale residue study in Alaska. The main findings are supported by previous residue research of smaller scale (Anderson et al., 2017; Farrell et al., 2014; Jeanotte et al., 2012; Solazzo and Erhardt, 2007). The aquatic nature of hunter-gatherer pottery function is becoming more apparent. The question remains why pottery was so important for the processing of aquatic products?

Insights into function

The benefits of fish oils to human health are well-known today, but also in the past. Especially in the Arctic, aquatic oils are an essential commodity. In these regions where it is hard to obtain enough nutrients, vitamins and minerals from the diet, aquatic oils are vitally important for human survival. Oil may be rendered from marine mammals, but can also be found in fatty fish species such as salmon. In the (sub)Arctic, seasonality is very pronounced, and the seasonal spikes of resource availability (e.g., salmon runs, marine mammal migrations) would have demanded an efficient processing technology to rapidly turn over large amounts of resources for long-term storage. The ability to quickly and efficiently render aquatic oils in a controlled way demanded the use of a durable container that could be directly heated. Stone bowls and pottery were crucial to this process. Without durable containers the rendering of oil took longer and was more prone to failure due to unexpected temperature changes. This would have been especially problematic in the Subarctic, where temperatures are generally higher. The exceptional high lipid concentrations in all Alaskan pottery samples (as well as in stone bowl and griddle stone surface residues), attests to the large proportion of fats and/or oils in the original content of the vessels. Relatively high C/N ratios furthermore indicate that vessels were used to process oily substances. We contend that pottery in Subarctic Alaska fulfilled an important role in the processing and storing of aquatic oils.

Methodological challenges and questions for future research

This research comprises the first systematic study of Southwest Alaskan pottery function. Through the application of lipid residue analysis of about one hundred samples, this research has illuminated for the first time what pottery in this area was used for. Through the various case studies a strong start was made to answer a variety of research questions raised at the start of the project. Naturally, opening up this course of research has generated a set of new questions that allow for a wealth of novel research in the future. During the project several challenges were encountered of methodological as well as interpretative nature. Most were overcome, but some will need additional research. Nonetheless, with this PhD research project a successful start has been made to unravelling the mysteries of the adoption of pottery in the New World (sub)Arctic.

Manufacture-derived lipids

The foremost challenge for this research project is highlighted in the ethnographic literature discussing early-historic pottery in Alaska. It was repeatedly described that aquatic oils and blood were used in the manufacture of pottery, to aid in its waterproofing (for an overview see Anderson, 2019). The implications of this to our lipid results could be very significant, as the results may reflect the production of pottery instead of its use as a cooking vessel informing us on prehistoric subsistence and diet. To overcome this problem I designed an experiment. Clay was mixed with salmon oil and subsequently fired at different temperatures, in order to observe whether manufacture-derived lipids are removed during firing. We found that all lipids, even very high added amounts, were removed when pottery was fired at temperatures of 400 °C and higher. Petrography, combined with a simple water (sintering) test, showed that the Alaskan pottery tested in this research was consistently fired at temperatures over 550 °C. This positive result allows to conclude that the lipid results presented in this thesis are from the use of the pottery, and not from its pre-firing production stage. This is a significant finding that greatly strengthens the results presented in this thesis, and of lipid residue research in general. A paper presenting the results of this experiment was published in *Archaeometry* and is presented here in chapter 4.

Compound specific isotopes

The carbon isotopes of individual fatty acids C_{16} and C_{18} in lipid samples allow for the differentiation between species (groups) based on their habitat. While this is a great tool to further determine the origin of the lipids, the resolution of this distinction is not always high enough. Of main interest to this research is the distinction within the aquatic spectrum. While the difference between freshwater species and marine species are easily observed, it is more difficult to separate anadromous species from marine, and it is impossible to detect marine fish vs. mammals. That makes lipid residue analysis a rather blunt tool for exploring variability within the subtle gradations of the aquatic spectrum. Nonetheless, in the results of this research clear trends were visible where isotopes were either more or less depleted on the marine scale.

In the (sub)Arctic isotope values of certain species may be difficult to compare to modern reference values of species originating in more temperate climate zones (e.g., ruminants: caribou vs. cow). To overcome this an attempt was made to acquire compound specific isotope values of archaeological bone lipids from Alaskan archaeological sites (mainly Aleutian), in order to expand the reference database. However, testing of compound specific isotope values of caribou bone lipids yielded varying and seemingly unreliable results. The enriched $\delta^{13}C$ values of caribou bone lipids could even be interpreted as marine. While the $\delta^{13}C$ values of bone lipids may not directly reflect those of tissue, this issue needs to be further investigated (Colonese et al., 2015). One way to establish the difference between marine and caribou samples in the case of strange isotopic values is to assess the SRR% of phytanic acid (Lucquin et al., 2016a). There is no reference database of such values for caribou, while such a database would be very valuable for the continued research of organic residue analysis in Alaska and other areas where caribou may have represented a possible resource.

Other applications of lipid residue analysis

The method of organic residue analysis is continuously being developed. Several studies have already shown the potential of its application to other materials such as to soil from activity areas and hearth features (Choy et al. 2016; Kedrowski et al. 2009; Buonasera et al. 2015). This will allow us to extend lipid residue research further back in time, into the pre-pottery stage, especially in areas of good archaeological preservation such as the (sub)Arctic. This would open up the possibility to compare resource exploitation of before and after pottery appears, and to register the changes that were brought along with the adoption of this new technology. How far stretches the antiquity of aquatic adaptations in prehistoric Alaska? Were pre-pottery cultures already exploiting river fishing? Or was this truly linked to the arrival of the Norton tradition, and pottery, in Alaska? Such questions remain open for future research, but some work has been done. For instance, Buonasera et al. (2015) found that aquatic resource processing dates back into Arctic Small Tool tradition times, hundreds of years before Norton introduced the first pottery in Alaska. This is an interesting course of research that would be especially fitting at stratified sites (see Bondetti et al., 2019), with both non-ceramic and ceramic layers which are plenty in Northwest Alaska, and in Siberia (e.g., along the Lena River, or at the Ushki V site in Kamchatka). Furthermore, applying organic residue analysis to a variety of material culture and activity zones (e.g., soil, hearths), also within the pottery horizon, will allow for the development of a broader view of (sub)Arctic culinary practices.

Proteomics

Another very exciting course of research is proteomics. Protein research in pottery residues allows for a much higher resolution, making it possible to identify specific species and in some cases even the specific origin of the protein in the body. The application of this method to pottery residue research has proven its potential at the Alaskan coastal site of Point Barrow where Thule pottery was successfully tested for the presence of proteins, and was concluded to have been used to process a harbour seal (Solazzo et al. 2008). This method could be of great value in discrimination between aquatic, and other, species, and could have significant implications for the interpretation of archaeological contexts. Because of the excellent preservation of Alaskan residue samples Dr. Jessie Hendy and Krista McGrath attempted to extract proteins from the carbonized crust of pottery samples of the NAK8 Thule site on the Alaska Peninsula. Unfortunately, no proteins were preserved in these samples. This may be due to the extensive storage time of the sherds (since 1998), or it could be due to the very oily character of the samples as indicated by high C:N ratios. Such samples are generally low in proteins. Nonetheless, in the (near) future proteomics may prove an invaluable addition to pottery residue studies, especially when working with freshly excavated materials.

Future areas for (sub)Arctic lipid research

This research has made a significant contribution to our knowledge of the trajectory of Alaskan durable container technologies and specifically the adoption of pottery. These results are significant locally, but also in the light of larger patterns of hunter-gatherer-fisher pottery in Eurasia. Nonetheless, (sub)Arctic pottery residue research is still in its infancy, with only a few residue studies to date (Anderson et al., 2017; Farrell et al., 2014; Heron et al., 2013; Jeanotte et al., 2012; Solazzo and Erhardt, 2007). There are several areas where residue analysis of pottery could be crucial for the understanding of the larger processes of pottery dispersal, adoption and rejection. While we draw conclusions on the adoption of pottery into the New World, we lack residue data of the very earliest pottery from the Bering Strait region where the technology presumably entered Alaska. Residue analysis of pottery from Alaskan sites such as Iyatayet (Tremayne et al., 2018), Cape Nome, and Choris is needed to fill in the gaps. To test diversity in pottery function the few occurrences of inland pottery in Alaska (e.g., at Onion Portage), should also be tested for organic residues.

The link between Alaskan pottery and that of Northeast Asia, and specifically Siberia, has long been apparent (Ackerman, 1982). While the implications of this connection for pottery function have been explored here, it was beyond the scope of this research to include Siberian pottery samples to test for residues. Nonetheless, it is vital to test Siberian pottery in a systematic way. The lack of knowledge of pottery function as well as of solid radiocarbon dates from this area makes it very difficult to comprehend the timing, pace and drivers of this major pottery dispersal event. Only by systematically testing well-dated Northeast Siberian pottery by organic residue analysis, will patterns in pottery function truly stand out. Here it was predicted that the riverine Northeast Siberian pottery was used predominantly for the processing of aquatic resources, based on the locations of these pottery-bearing sites on large river systems. Organic residue analysis is a good tool to test the validity of that hypothesis.

Final conclusion

While more work needs to be done, this doctoral research has made a clear contribution to the knowledge of Alaskan container technologies, social and cultural life, but also advanced methodological knowledge. It includes novel work on several subjects: 1) stone bowls from the Aleutian Islands were never before discussed in the literature, nor subjected to residue analysis; 2) organic residue analysis was for the first time applied systematically to the earliest pottery in Alaska, 3) as well as to the pottery of Kodiak Island, another neglected artefact category; 4) this research addressed the problem of manufacture-derived lipids and their visibility in archaeological samples through an innovative experimental study; and 5) this research provided excellent examples of aquatic lipid profiles that were exceptionally well preserved and can function as reference material for other studies. A co-authored paper accepted by *Antiquity* (Taché et al., 2019) that uses one of the samples of this project as a reference, attests to this.

This is a novel and important contribution to Alaskan archaeology and anthropology, the archaeology of interconnections across the Bering Strait, as well as for hunter-gatherer pottery research in general. Furthermore, it provides new information about the direct ancestors of many native cultural groups, that still live in the area today. Its conclusions illustrate the importance of making connections and comparisons beyond a defined research region. Additionally, the research reaffirms the relevance of the method for the investigation of not just pottery function, but also subsistence practices, cultural innovation and connection, and the larger trajectory of hunter-gatherer-*fisher* pottery adoption, dispersal and rejection, in both the Old World and the New.

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