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Stable carbon, nitrogen and sulphur isotope analysis of permafrost preserved human hair from rescue excavations (2009, 2010) at the precontact site of Nunalleq, Alaska

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ABSTRACT

The reconstruction of diet and subsistence strategies is integral to understanding hunter-gatherer societies in the past, and is particularly of interest in high latitude environments as they can illuminate human-environmental interactions and adaptations. Until recently, very little archaeological research had been undertaken on the Bering Sea coasts of the Yukon-Kuskokwim Delta, and relatively little is known about precontact lifeways in this region. Here, we present stable carbon, nitrogen and sulphur isotope data from non-mortuary human hair excavated from Nunalleq (c. 1300 CE–1750 CE) – a precontact village site in Western Alaska. Now the focus of a major research project, excavations at Nunalleq began as a rescue excavation, as the site is eroding rapidly into the Bering Sea. Following an initial pilot study on cut strands representing a small number of individuals, a larger body of isotope data has now been generated from the first phase of the investigations of Nunalleq (2009, 2010). These new data, including sulphur isotope values, provide further evidence for the subsistence strategy at the site, including a mixed diet of marine and terrestrial foods (but likely dominated by salmonids). In addition, these new data from Nunalleq highlight some dietary variability amongst the inhabitants of the site. Analyses of additional longer hair strands suggest this variability may not be exclusively due to seasonal variation, and may evidence inter-personal dietary differences. Data from Nunalleq are compared to isotope data from previous studies of Thule-era and earlier Alaskan sites, and to isotope data from Thule sites in Canada and Greenland and the potential of ongoing and future research at the site is discussed, along with the implications for our understanding of Thule subsistence strategies and precontact lifeways on the Yukon-Kuskokwim Delta.

1. Introduction

The Yukon-Kuskokwim Delta, Alaska (Fig. 1) is the core of the Central Yup'ik culture area, which is well-documented ethnographically but poorly characterised archaeologically. This area of coastal Western Alaska, under-researched compared to the more southerly regions of Kodiak (Clark, 1966, 1998; Jordan and Knecht, 1988; Fitzhugh, 2004; West, 2011) or the Aleutian Islands (Laughlin, 1951; Knecht and Davis, 2001, 2008; Balter, 2012), has the potential to reveal important information about the peopling and precontact cultures of Alaska, and past human-environmental relationships along the Bering Sea coast. The need for (and potential of) archaeological investigations in this region has been highlighted by recent excavations at the site of Nunalleq (GDN-248), near the village of Quinhagak, Alaska. Yup'ik for 'the old village', Nunalleq was revealed along an eroding coastline, a product of recent climatic change, which has also led to a reduction in permafrost and more unpredictable weather conditions in the region, along with other impacts such as local infrastructural damage and changes in the abundance, distribution and seasonality of plant and animal resources (Callaway et al., 1999; ACIA, 2004; Hinzman et al., 2005; Moore and Huntington, 2008; Joly et al., 2011). Permafrost and waterlogged soils at Nunalleq have led to the preservation of tens of thousands of *in situ* artefacts at the precontact village site (c.1300 CE–1750 CE), and an extensive assemblage of organic ecofactual and bioarchaeological remains including animal bone, fur, and cut strands of human hair from non-mortuary contexts (Britton et al., 2013; Farrell et al., 2014; Forbes et al., 2015). Following several years of rescue excavations, the site and its landscapes, are now the subject of a major research project and field investigation.

Modern Yup'ik and Cup'ik cultures are assumed to be descended from the Western Thule Tradition which may have originated in Northern Alaska spreading down the coastal Bering Sea as far south as the Alaska Peninsula shortly after 1000 years Before Present (BP) (Dumond, 1984). Indeed, recent mtDNA analysis of human hair from

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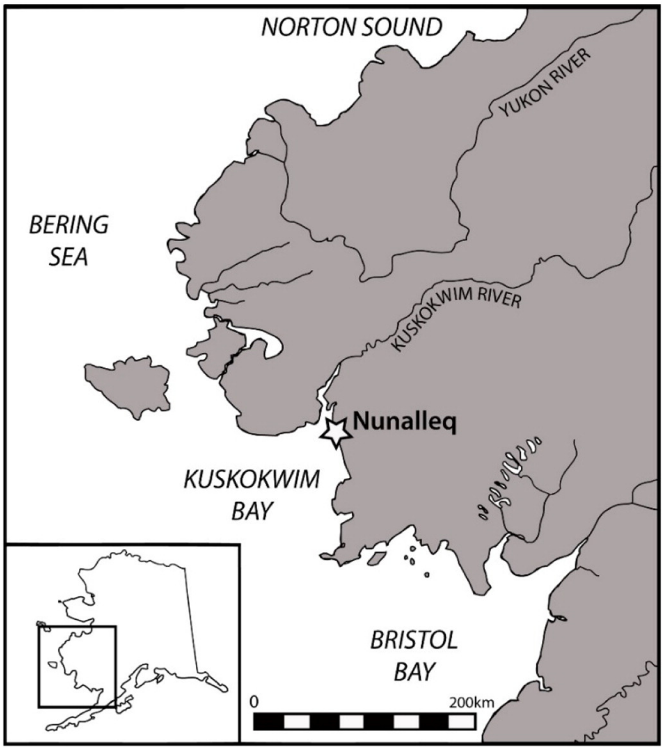

Fig. 1. Map of Western Alaska showing the location of the Nunalleq archaeological site. Adapted from Britton et al. (2013: 449, Fig. 1).

the Thule-era site of Nunalleq, confirms genetic continuity between ancestral and recent populations in the area (Raghavan et al., 2014). Today, and in recent history, traditional Yup'ik subsistence diets incorporate a wide variety of resources including marine mammals, salmonids, caribou, sea birds, sea fish, small mammals and other animals, as well as berries and limited other vegetative foods (Fitzhugh and Kaplan, 1982; Barker and Barker, 1993). However, ethnographic accounts may not accurately reflect the deeper Yup'ik past. This is especially important in a region that has seen profound and dramatic climate changes over the last 1000 years (Mann et al., 1998; Hu et al., 2001), including a period of warming known as the Medieval Warm Phase (~900 CE–1350 CE) to the later cooling of the Little Ice Age (~1350 CE–1900 CE) (Mann, 2007). Inversely, understanding change and continuity in subsistence strategies and dietary habits, especially at latitudinal and climatic extremes, and during periods of environmental change, is important to understanding past human adaptations to those changes, particularly in hunter-gatherer-fisher societies.

In Alaskan archaeology, the reconstruction of past diets and subsistence strategies has relied primarily upon analysis of faunal assemblages; lithic, antler, bone and wooden artefacts; ethnographic accounts and oral histories. While these proxies provide a good picture of general subsistence activities, the stable isotope analysis of human tissues is a useful additional tool in archaeology as it can provide an estimate of foods actually consumed, offering an opportunity to reconstruct the diets of ancient humans directly from their physical remains. Stable isotope data can therefore provide unique dietary perspectives on the scale of individual people, and through intra-tissue, inter-individual and cross-site comparisons, can illuminate past dietary variability on multiple levels. However, few archaeological isotope studies have been undertaken in Alaska (e.g. Coltrain, 2010a; Byers et al., 2011), with only a single pilot study on a small number of archaeological samples in the Yukon-Kuskokwim Delta region (Britton et al., 2013).

Here we present stable carbon, nitrogen and sulphur isotope data from the analysis of permafrost preserved human hair from non-mortuary contexts from the rescue excavations at the site of Nunalleq, Alaska (2009, 2010). Following on from the pilot study, these data provide further evidence for a mixed subsistence strategy, including marine and terrestrial foods, albeit dominated by marine and riverine protein (likely salmonids). In addition to confirming preliminary interpretations of diet at Nunalleq made in a pilot study, the new data presented here also highlight some dietary variability amongst the inhabitants of the Nunalleq site. Analyses of longer hair strands suggest this variability may not be exclusively due to seasonal variation, but may highlight inter-personal dietary differences. Data from Nunalleq are compared to other Alaskan, Canadian and Greenlandic Thule-era and earlier period sites, and variability in late prehistoric diet is explored. The potential of ongoing and future research at the site is discussed, along with the implications for our understanding of Thule subsistence and precontact lifeways on the Yukon-Kuskokwim Delta.

2. Reconstructing palaeodiet using stable isotope analysis

The δ^{13}C, δ^{15}N and δ^{34}S values of bodily proteins such as keratin and bone collagen reflect the δ^{13}C, δ^{15}N and δ^{34}S values of ingested dietary protein (DeNiro and Epstein, 1978, 1981; Schoeninger and DeNiro, 1984; Richards et al., 2003), albeit with minor contributions from other dietary macronutrients (Warinner and Tuross, 2009; Froehle et al., 2010). Different tissues offer different temporal resolution: bone collagen can indicate long-term (~10 years or more) dietary isotopic averages (Ambrose and Norr, 1993; Hedges et al., 2007), whereas incrementally-developed tissues such as teeth (dentinal collagen) and keratinous tissues such as hair/fur, nails and claws offer shorter-term records of protein intake and time-series information (e.g. Roy et al., 2005; Wilson et al., 2007; Beaumont et al., 2013; Montgomery et al., 2013). Human hair grows at a rate of ~1 cm per month (Valkovic, 1977), and therefore can provide intra- and inter-annual records of an individual's dietary habits, although it should be noted a variety of environmental, hormonal, age-related, and other factors can influence this growth rate (Trüeb and Tobin, 2010).

Carbon isotope ratios (δ^{13}C) are used to discriminate between marine and terrestrial dietary protein sources, and nitrogen isotope ratios (δ^{15}N) can be used to determine the trophic level of the protein consumed. In general, δ^{15}N values increase by 3–5‰ with each step up the food chain, whereas δ^{13}C values are enriched by ~1‰. δ^{15}N values can also be used to indicate freshwater or marine dietary inputs, as aquatic ecosystems tend to have longer food chains (Richards et al., 2001b). Therefore, the measurement of δ^{13}C and δ^{15}N values of humans and different animal species can allow the reconstruction of trophic relationships within archaeological ecosystems, and allow the identification of likely sources of human dietary protein.

Sulphur isotope ratios (δ^{34}S) of bone collagen and other body proteins also reflect dietary protein intake and can be used to distinguish between marine and terrestrial influences in the diet. Sulphur isotope ratios in plants and animals are derived from soil sulphur, which is influenced by both the local lithology and rainfall. Terrestrial organisms normally have sulphur isotope values of 5–10‰ (Peterson and Fry, 1987), but can be closer to 0‰ (Nehlich and Richards, 2009), and freshwater organisms exhibit similar values ranging from −5 (or lower) to 10–14‰ (Nriagu et al., 1991; Nehlich and Richards, 2009). Oceanic sulphate has a mean value of ~20‰ (Rees et al., 1978), therefore marine organisms or organisms consuming marine protein are likely to have more elevated δ^{34}S values closer to this value (Peterson and Fry, 1987; Nehlich and Richards, 2009). Sulphur isotope values above 14‰ in mammalian bodily proteins are consistent with a significant marine contribution to the diet (Nehlich, 2015), although values above this 'threshold' (Nehlich, 2015: 10) have also been observed in terrestrial food-webs in coastal regions due to the sea spray effect (Richards et al., 2001a; Nehlich, 2015).

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