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Phosphate as an indicator of occupational intensity at shell midden sites on the central coast of British Columbia☆

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ABSTRACT

We use reagent colorimetry to measure phosphate concentrations in fine-fraction matrix from shell midden sites on the central coast of British Columbia, Canada. The results show strong correlations with fish bone densities (that is, number of identified specimens per litre of fine fraction matrix) and site area, which have been used previously to infer the intensity of site occupation in the region. Despite a long history of use in shell midden studies, elemental analysis, and phosphate analysis in particular, is not commonly applied in these contexts. Using multiple lines of evidence, we show that phosphate measurement from small amounts of matrix from bucket-auger samples or cores is an inexpensive and replicable way to assess variability in the intensity of site use, conceptualized as a function of the scale, duration, and frequency of occupational events, between locations and over time. This method should be easily extended to other shell midden sites, especially where the majority of fine matrix is of anthropogenic origin.

1. Introduction

The archaeological analysis and interpretation of shell midden sites presents a number of methodological issues unique to their form and formation history. These include sampling (Lyman, 1991; Peacock, 1978), chronology building (Stein et al., 2003), and determination of the scale and nature of residential activity and site function (Ascher, 1959; Bailey, 1977; Martindale et al., 2009). The nature and relative intensity of residential occupation has been of particular interest in recent debates regarding the formation and potential ritual meaning of some shell middens. Although the circumstances vary, a critical issue is the extent to which they form gradually over time as the result of everyday residential activity and discard of shell and other refuse, or result from deliberate efforts to construct shell mounds as ritually charged features on the landscape (Claassen, 2010, 2013; Gaspar et al., 2014; Klokler, 2014; Luby et al., 2006; Marquardt, 2010; Villigran, 2014; Villigran et al., 2011). More fundamental discussions have concerned the distinction between natural and anthropogenic shell deposits (Rosendahl et al., 2007).

We describe the use of phosphorus as a tool for determining residential activity on the central coast of British Columbia. In conjunction with other lines of evidence, phosphorus analysis distinguishes reliably in this case between long-term residential village sites, shorter-term campsites, and fish processing locations, helping to resolve regional problems in matching the size, form, and contents of shell middens to their use as residential or specific activity locations (Cannon, 2002, 2013). We focus on the question of occupational intensity, which can be defined as a combination of the scale, duration, and frequency of site occupation. This measure represents a continuum from year-round residential occupation by sizeable village populations to camp site visits by small numbers of people for a few days at a time spaced intermittently over variable numbers of years.

Shell middens build over time as the result of any form or intensity of occupation, but depending on the overall span of site use and potential temporal variability in site-use patterns the accumulations that result from different intensities of occupation might not be readily distinguishable from one another. Site features and contents typically provide the basis for inferring the intensity and form of activities, but each has limitations unique to deep and complex shell midden deposits.

Defining shell middens as the product of residential village occupation is made possible in some contexts by the presence of discernable house features on the surface (Archer, 2001; Koike, 1986), but in deeply

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buried deposits, house floors and other structural features and activity areas can be very difficult to define (Ames et al., 1992; Rowley-Conwy, 2013). The problem is exacerbated by complex stratigraphy, in which individual layers and lenses can be hard to see and often fade from view over small areas (Estévez et al., 2013; Hester, 1978; Peacock, 1978). Limited area excavations further complicate the task of defining contemporaneous deposits and identifying features, especially those associated with large residential structures (Ham et al., 1986; Lyman, 1991). In the absence of definitive feature data, artifacts might be expected to provide clues concerning the nature of site occupation and activity, but on the Northwest Coast > 90% of material culture was comprised of perishable materials, such as wood and plant fiber (Croes, 2003). The relative paucity of artifacts in Northwest Coast shell middens is well noted, and large excavation volumes are considered necessary to obtain representative samples of artifact content (Lyman, 1991).

In contrast to rare or equivocal evidence of structural features and the relative rarity of artifacts on the Northwest Coast, shell middens generally contain a rich array and abundance of well-preserved vertebrate and invertebrate faunal remains, which are used to define focus and change in subsistence economies (Cannon, 1991; Jerardino, 2013) and for environmental reconstruction (Andersen, 2007). The seasonal availability of fauna and seasonal growth increments in shell are also used to define seasonality of site occupation (Burchell et al., 2013). In combination, the relative abundance and variety of seasonal indicators have been used to argue for residential village occupation at the site of Namu on the central British Columbia coast dating back to at least 7000 BP (Cannon and Yang, 2006). In this case, the argument for residential duration and intensity rests largely on the abundance and seasonal availability of salmon and herring, two staple food resources, but recent stable isotope sclerochronology analysis of shell also supports multi-seasonal occupation at Namu (Burchell et al., 2013). Although Namu lacks clear structural features, multi-seasonal village settlement, comparable to the winter village pattern defined ethnographically for the region, remains the simplest explanation for the available faunal data.

The Namu faunal evidence was obtained primarily from six seasons of full-scale excavation (1968–70, 1977–78, 1994) (Hester, 1978; Carlson, 1996). The resulting knowledge of the site and the desire to develop an understanding of regional settlement and subsistence patterns led to the development of coring and bucket-auger sampling as a less costly and less invasive investigation strategy (Cannon, 2000a, 2000b). The initial results of auger sampling at Namu also produced clear and consistent evidence of intensive herring fishing, which supported the site's interpretation as an early and continuing village settlement. But the exclusive use of bucket-auger sampling and coring at 29 other shell midden sites in the region (Fig. 1) yielded a much smaller range of evidence on which to base interpretations of site activities. It was in this context that the application of phosphorus analysis was explored as a potentially independent indicator of occupational intensity.

2. Archaeological context

British Columbia's central coast landscape ranges from the low relief of the islands and adjacent mainland on the outer coast to the higher relief and steep-sided inlets of the larger island and mainland regions to the east. Coring and bucket-augering was undertaken at sites in the immediate Namu vicinity and the adjacent outer coast within traditional Heiltsuk territory, and in Rivers Inlet in traditional Wuikinuxv territory to the southeast. The goal was to provide historical and settlement pattern contexts for Namu, while exploring site variability across broad environmental zones (Cannon, 2013).

The small volume of material collected in a 7 cm diameter bucket-auger sample proved adequate for the recovery of more ubiquitously distributed midden constituents, including shell and fish bone (Cannon, 2000a). Site chronologies were developed from dates obtained from stratigraphically intact cores taken adjacent to auger samples (Cannon, 2000b), but auger sampling typically does not permit the attribution of materials to particular deposition contexts. This strategy is therefore, conservatively, most appropriate for characterizing site averages for midden contents. The most effective indicators of occupational intensity have been the density and variety of fish remains together with the overall surface area of site deposits. These have allowed for the classification of long-term residential sites and smaller, shorter-term encampments (Cannon, 2013).

Using extensions, as needed, to reach the full depth of deposits, bucket-auger samples were collected in measured (ca. 7–15 cm) vertical increments, then bagged and returned to the lab for analysis (Cannon, 2000a). All shell and fish bones in the > 2 mm portion of the matrix were identified, and the finer matrix was retained for further analysis. As is typical of shell middens in the Pacific Northwest, bone preservation at all sites was excellent. Herring and salmon predominated among the vertebrate faunal remains recovered, though 24 additional fish taxa were also identified (Cannon, 2000a, 2013). Butter clam and barnacle, and, to a lesser extent, bay mussel dominated the shell component of the matrix, though a variety of other taxa were also present. The relative abundance of different shellfish species varied between locales (Cannon et al., 2008). The Rivers Inlet sites differed from those in the Namu area primarily in their composition and form. Most consisted of thin, horizontally-deposited layers of crushed mussel and mussel-attached barnacle shell, but they were similar in their vertebrate fauna content, which consisted mainly of herring and salmon bone (Cannon et al., 2011).

Based on their large size and in some cases evidence of permanent structures on the surface, some sites could be readily classified as residential villages. Equally, the ephemeral or patchy nature of midden deposits at some sites and the constrained areas available for the construction of dwellings at others indicated they could only be the remains of short term, smaller-scale encampments, occupied repeatedly over the course of millennia in some cases. With few exceptions, the density and variety of fish remains is correlated with relative site area (Cannon, 2013). Villages occupied for longer periods by greater numbers of people exhibited greater density and variety of fish remains, while sites thought to have been occupied less frequently or for shorter periods by smaller groups exhibited much less density and variety of fish. This mutual association among site area, the density and diversity of vertebrate faunal remains and occupational intensity intuitively makes sense, but the precise nature of the relationship is less clear.

Fish bone density was standardized by the volume of fine (< 2 mm) matrix to control for the volume-exaggerating effects of large rocks and whole and coarsely broken shell, but its use as a measure of the scale and duration of site occupation raises questions about site formation processes. How do occupations at different sites produce the same volume of fine matrix but different densities of fish bones? In other words, if fine matrix and faunal deposition are both products of site occupation how can they occur at different rates at different types of sites?

The observed differences could be a function of differences in subsistence practices. If residents at small, short-term encampments subsisted to a greater extent on foods other than fish while village residents relied more heavily on fishing and the consumption of salmon stores, that would account for a lower density and diversity of fish remains at most smaller sites. Alternatively, a greater proportion of the fine matrix at more intermittently occupied sites might consist of non-cultural deposition during periods of site abandonment. Working against this possibility is the fact that significant fluvial or aeolian deposition is unlikely in this region. Where major streams are present, sites are raised well above high-water levels, and there are no large exposed stretches of beach sand that might be a source of aeolian deposits. The decay of organic forest litter might contribute to sediment build-up at sites long abandoned, but the accumulation from organic decay would be minimal.

A perhaps more likely alternative explanation is that the rate of fish