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An experimental approach to distinguishing different stone artefact transport patterns from debitage assemblages

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ABSTRACT

This paper experimentally demonstrates the ability of a set of indices to distinguish between different stone artefact transport patterns represented in debitage assemblages. Stone artefacts were transported extensively in the past and this is an important component of technological organisation. However, most stone artefacts occur as part of debitage assemblages. From these assemblages, where mostly non-transported artefacts remain, it can be challenging to identify what artefacts, if any, were transported in anticipation of future use. A series of indices; the cortex ratio, volume ratio, flake to core ratio, non-cortical to cortical flake ratio and flake/core diminution tests are presented to meet this challenge. These are tested on an experimental assemblage where three different transport scenarios are simulated. Results suggest that the indices are sensitive to artefact transport and are capable of empirically distinguishing between the three transport scenarios, even when raw material form varies. The results also indicate that artefact transport is capable of exerting a significant influence on stone artefact assemblage formation.

1. Introduction

In archaeology, the importance of stone artefact transport as a behavioural strategy is noted as far back as the Oldowan (Potts, 1991; Toth, 1985, 1987). The ability to transport, and 'curate', different toolkits in anticipation of future use(s) is an important component of how past technology was organised in relation to localised socio-economic, environmental and functional contexts, especially among highly mobile hunter–gatherers (Andrefsky, 2009; Bamforth, 1986, 2003; Goodyear, 1989; Kelly, 1988; Kuhn, 1992, 1994; Meltzer, 1989; Nelson, 1991; Odess and Rasic, 2007; Shott, 1986, 1996; Torrence, 2001). Along with raw material constraints (e.g. Andrefsky, 1994; Brantingham et al., 2000; Elston, 1990), variation in these contexts placed different constraints on hunter–gatherer technology and thus different transport patterns were advantageous for different contexts. For example, large, *thin* flakes might be transported to ensure a sharp edge is available when required and, because of their size, large flakes generally had longer use-lives than smaller flakes (Andrews et al., 2015; Close, 1996; Dibble, 1997; Douglass et al., 2008; Eren, 2013; Key and Lycett, 2014; Lin et al., 2013; Morrow, 1996; Odess and Rasic, 2007; Roth and Dibble, 1998; Terradillos-Bernal and Rodriguez, 2012). Due to their durability and use-life potential, *thick* flakes may also represent a good transport solution under conditions of high mobility (Eren and Andrews, 2013). Transporting cores, or core-tools, may also represent an attractive option because flakes can be created as required until the core is exhausted (Bamforth, 2003; Braun et al., 2008a; Close, 1996; Kelly, 1988; Kelly and Todd, 1988; Nelson, 1991:73–76; Phillipps and Holdaway, in press). However, cores can be large and heavy items so their transport can come at some cost (Beck et al., 2002). To avoid the transport cost, cores can be 'prepared' at their source location by removing unnecessary exterior weight and/or they can be stockpiled in strategic locations for use over multiple occupations (Close, 1996; Kuhn, 1992, 1995). Numerous small flakes, as opposed to a smaller number of large flakes, may also be a desirable transport option (Kuhn, 1994) especially where microliths are an essential part of the transported toolkit (e.g. Hiscock et al., 2011). In Australia, the ethnographic literature indicates that a wide variety of artefacts might be used and transported depending on localised context (Holdaway and Douglass, 2012). In addition, factors such as the design, flexibility, function and maintainability of artefacts influenced past transport decisions (Bleed, 1986; Goodyear, 1989; Kuhn, 1992; Nelson, 1991). However, these different systemic stone artefact transport patterns will clearly leave a variety of different archaeological signatures

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where it can be difficult to distinguish what signature belongs to what transport pattern. Addressing this issue represents an important goal towards understanding past technological organisation and the contextual constraints operating on past transport decisions.

Some transport patterns can be distinguished through application of techniques such as geochemical sourcing (e.g. Boulanger et al., 2015; Braun et al., 2008b; ten Bruggencate et al., 2015; Nash et al., 2013; Shackley, 2011), refitting (e.g. Close, 2000; Delagnes and Roche, 2005; López-Ortega et al., 2011) and stone tool retouch indices (e.g. Andrefsky, 2008; Clarkson, 2002a, 2002b) to stone artefacts that were demonstrably transported in the past. However, demonstrably transported stone artefacts are not common in the archaeological record where most stone artefacts occur as part of debitage assemblages (here defined as including all components of flaked stone discarded at a given site (or other analytical unit) including cores, flakes, flaked pieces and retouched/used tools). Debitage assemblages commonly consist of thousands of stone artefacts manufactured from a limited range of localised raw material(s) where the desired items were either used expediently (Nelson, 1991:64) or transported away (e.g. Douglass et al., 2008). As such, all that remains in debitage assemblages (with the possible exception of non-local raw materials from other transport events) are those artefacts which were *not* transported from their place of production. Although the applications of new methods are beginning to show the extent to which debitage assemblage formation was influenced by artefact transport in the past (e.g. Douglass et al., 2008; Holdaway et al., 2008), beyond establishing that artefact transport did occur in the past (and in the absence of demonstrably transported artefacts), it remains difficult to distinguish exactly what artefact transport patterns were responsible for past debitage assemblage formation, especially under conditions of varying raw material forms.

To help address these issues, this paper aims to use a novel combination of the cortex ratio, volume ratio, flake to core ratio, non-cortical to cortical flake ratio and a flake and core size diminution to provide quantitative criteria capable of distinguishing between different stone artefact transport patterns. These indices will be rigorously tested using an experimental assemblage where different artefact transport scenarios will be simulated and the indices applied to each simulation. Each index measures different aspects of stone artefact assemblage composition (see below) meaning that, as assemblage composition is altered by different artefact transport scenarios, each index should respond differently where the results may be characteristic of different transport patterns. Further, the influence of different stone artefact transport patterns on assemblage formation can be closely tracked.

2. Background

Extensive archaeological application of the cortex and volume ratios have established both as robust measures for artefact transport behaviour (Ditchfield et al., 2014; Douglass et al., 2008; Douglass, 2010; Holdaway et al., 2008, 2010; Phillipps, 2012; Phillipps and Holdaway, in press). While controlling for raw material shape and size, the cortex ratio determines whether all the cortical products of reduction are present in a stone artefact assemblage where cortex is the weathered surface of a rock. It does this by comparing, in the form of a ratio, the observed amount of cortical surface area with the expected cortical surface area (Douglass et al., 2008). The expected cortical surface area is the amount which should remain in the assemblage under expedient conditions. If no artefact transport occurred (i.e. the assemblage was expediently produced) then the observed amount of cortical surface area will not differ from the expected amount. If artefact transport did occur, the observed amount of cortical surface area will differ from the expected amount. However, the cortex ratio can be limited in applicability because it mostly requires assemblages to be produced from fully cortical nodules.

Dibble et al. (2005) provide the experimental proof of concept while two separate studies in western New South Wales, Australia (Douglass et al., 2008; Douglass, 2010; Holdaway et al., 2008) provide the initial archaeological applications of the cortex ratio method. In both archaeological studies, observed cortex ratios are significantly below one due to large cortical flake transport. A host of further archaeological work, experimental studies and computer simulations (Ditchfield et al., 2014; Douglass, 2010; Douglass and Holdaway, 2011; Douglass et al., 2008; Lin et al., 2010; Parker, 2011), have determined this is the case while further applications in Egypt (Holdaway et al., 2010; Phillipps, 2012; Phillipps and Holdaway, in press), Middle Palaeolithic France (Lin et al., 2015), and the southern Cook Islands (Ditchfield et al., 2014) have reinforced the archaeological applicability of this methodology.

The volume ratio is similar to the cortex ratio, except that it uses assemblage volume instead of cortex (see below for measurements). This can be advantageous because the volume ratio does not always require assemblages to be produced from fully cortical nodules. Compared to the cortex ratio, however, the volume ratio has seen only three applications (Ditchfield, 2011; Ditchfield et al., 2014; Phillipps, 2012; Phillipps and Holdaway, in press) where it was successfully developed to track or check for the transport of cores (or core-tools) in the Fayum, Egypt (Phillipps, 2012; Phillipps and Holdaway, in press), south-western Tasmania (Ditchfield, 2011) and on Moturakau, Aitutaki (Ditchfield et al., 2014).

The other ratios and analytical techniques (the flake to core ratio, non-cortical to cortical flake ratio and the flake and core size diminution tests) have seen wide application in stone artefact analysis where they are commonly used to measure reduction intensity and occupation duration (e.g. Henry, 1989; Holdaway et al., 2004; Roth and Dibble, 1998; Shiner, 2006, 2008; Shiner et al., 2007). Compared to the cortex and volume ratios, these indices are more simplistic and not as extensively explored but their inclusion here will help further investigate the applicability of these indices and their relationship with artefact transport. For example, because each measure is essentially based on the frequency of complete flakes or cores (see below), it can be expected that, as these frequencies change in correspondence with artefact transport, the ratios will respond accordingly.

3. Materials: an experimental application

To test whether the set of indices is capable of distinguishing between different artefact transport patterns, an experimental approach was selected to simulate different stone artefact transport scenarios using an experimentally produced debitage assemblage. Three transport scenarios were selected for experimental simulation:

1. The transport of flakes from an assemblage produced from fully cortical nodules.
2. The transport of flakes from an assemblage produced from partially cortical nodules.
3. The transport of cores from an assemblage produced from fully cortical nodules.

As each of these transport simulations is carried out, the proposed suite of indices can be applied to the experimental debitage assemblage at set increments to quantitatively track assemblage compositional changes caused by the artefact transport simulations. Once the simulations are carried out, results can be compared