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# Lithic taphonomy in desert environments: Contributions from Fuego-Patagonia (Southern South America)

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This paper focuses on the contributions of taphonomic approaches to the study of lithic assemblages. Based on actualistic and archaeological case studies from Fuego-Patagonia (South America), here I summarize some of the main taphonomic issues identified for the regional lithic record which are of relevance for the archaeological research in other desert environments. Specifically, distributional patterns in lithic assemblages produced by wind are highlighted and main guidelines for pseudoartifact study are presented and discussed. Actualistic data show lithic artifacts up to 50 mm in size – or weighting ~13 g – can be moved by winds blowing at 90 km/h. Finally, a methodological exercise (Banyai's zoom) is proposed for lithic mimic recognition.



## 1. Introduction

*'A refined understanding of taphonomic mechanisms which affect stone artefacts would provide better basis for interpreting archaeological assemblages.'*

(Hiscock, 1985: 93)

Throughout the history of our discipline, theoretical as well as methodological advances changed the way we define, approach, and inquire into the archaeological record and its components (Trigger, 2006; Podgorny, 2008, 2009). One of these recent changes has been the incorporation of lithic artifacts into the realms of taphonomic studies (Hiscock, 1985, 2002; Dibble et al., 1997; Barton et al., 2002; Bordes, 2003; Borrazzo, 2004, 2006; Thiébaut et al., 2010; Borrero, 2011a, 2011b, 2014a, 2015; Eren et al., 2011; Domínguez-Rodrigo et al., 2011; Weitzel et al., 2014; Ugalde et al., 2015, among others). This inclusion does not imply assuming that artifact – as a subsample of rocks modified by hominins – are like organic remains but recognize that – although their undeniable higher toughness to bear the passage of time – they do suffer modifications (morphologically and/or spatially) in different patterned ways, as a response to temporal and environmental conditions (e.g. Bertran et al., 2012). Each of these modifications or alterations (at the level of the individual artifact and/or the assemblage) constitutes itself a record of archaeological interest since it provides insightful information about assemblage formation history. Furthermore, the study of such alterations may highlight taphonomic bias in the technological structure, composition, and spatial distribution of lithic assemblages which can influence our behavioral interpretations.

Within this general perspective on the stone components of the archaeological record, lithic taphonomy studies the effects of natural and cultural processes acting upon artifacts from their deposition until their recovery. This approach in lithic artifact analysis is also concerned with the identification and characterization of taphonomic processes capable of creating spatial or morphological (i.e. geofacts or pseudoartifacts) patterns similar to those produced by humans (also known as *background noise* see Borrero, 2001a, 2007, 2014a, 2015).

Due to their durability, lithic artifacts are the more frequent archaeological remains in Patagonian deserts and semi-deserts (≤400 mm annual rainfall, maximum wind speed ~150 km/h). Consequently, the reconstruction of hunter–gatherer behavior is often based primarily on the study of those materials. This situation emphasizes the need of incorporating a taphonomic perspective in lithic artifact analysis. Moreover, beyond their regional contribution, the results of the studies presented in this paper are also

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relevant to the broader realm of archaeological research in desert environments because they stress the need to search and isolate taphonomic patterns for accomplishing better interpretations of past human behavior.

In this paper I draw some of the main taphonomic trends in regional lithic assemblages from actualistic and archaeological research carried out in high-latitude Patagonian desert and semi-desert environments. The results presented here were obtained within the lithic taphonomy research program conducted in the region since 2002, which is part of the Regional Taphonomy research of Magallania Project, directed by Borrero (2001a, 2001b, 2007, 2014b) and Borrero et al. (2008). Lithic taphonomy program aims at characterizing *spatial* and *morphological* effects of taphonomic agents and processes on the regional lithic record. The former refers to changes in artifact distribution involving vertical and horizontal displacements, size selection, and changes in orientation, inclination, and position (i.e. exposed face). Morphological effects refers to postdepositional modifications introduced in artifact's formal attributes (outline, edge, surface, ridge, etc.) by physical and/or chemical weathering (breakage, abrasion, polishing, weathering rinds; Burroni et al., 2002; Goudie, 2004), and rock coating formation (salt crust, rock varnish, lichen growth; see Dorn, 2009). Within this perspective, pseudoartifacts represent an 'extreme morphological effect' of taphonomic processes operating in a particular environment.

Archaeological lithic assemblages studied in this paper were collected from sites and/or localities surveyed in Tierra del Fuego Province (Borrazzo, 2004, 2010, 2011a, 2014; Borrero et al., 2008; Borrazzo and Borrero, 2015 and references therein). Actualistic data presented result from longitudinal and short term experiments carried out in the study region as well as naturalistic observations and field collection of geofacts conducted throughout Patagonia (Borrazzo, 2010, 2011a, 2011b, 2013; Borrazzo and Borrero, 2015).

This paper assesses wind effects on surface lithic assemblages by means of actualistic data from Tierra del Fuego and explores the potential of different Patagonian environments to produce geofacts (or pseudoartifacts), i.e. rocks resembling artifacts. Main guidelines for pseudoartifact studies are presented and discussed, which include a methodological exercise of changing the scales of observation to identify lithic mimics.

## 2. Distributional taphonomic effects: assessing eolian transport

### 2.1. Regional background

The dominant strong winds from the SW – named *southern westerlies* – have a prominent role in the climate of Fuego-Patagonia (Frederiksen, 1988; Coronato, 1993; McCulloch et al., 1997) and are important taphonomic agents as well. Within northern Tierra del Fuego Province winds of 60 km/h blow more than 200 days per year, with gusts over 150 km/h (Isla et al., 1991; Vilas et al., 1999; Borrazzo, 2013). Also, we recorded 80 km/h winds during fieldwork in Chubut and Santa Cruz Provinces, where they can reach *ca.* 100 km/h (Servicio Meteorológico Nacional, 2005). Therefore, surface archaeological record in exposed-to-wind areas are subject to high energy processes (e.g. Borrazzo, 2004, 2006, 2013; Santiago and Oría, 2007).

The presence of vegetation reduces such wind effects by retaining sediments and artifacts within or below it. Wet fine-grain substrate also avoid eolian removal by 'sticking' materials to its surface, preserving artifacts with sizes as small as 10 mm in surface assemblages (Borrazzo, 2013; Borrazzo and Borrero, 2015). A related phenomenon, corrasion (eolian abrasion, Breed et al., 1997; Goudie, 2004) occurs in Patagonian desert–semi desert environments affected by strong winds. Dune fields – where dried and loose sand is available for eolian transportation-offer the most abrasive contexts for lithic artifacts at the regional scale (Borrazzo, 2006; Borrazzo and Borrero, 2015; Carranza, 2015). Naturalistic studies in the field and data collected from long term experiments set in Santa Cruz and Tierra del Fuego Provinces allow us to confirm that the strongest winds available in the region (over 100 km/h) have the capacity to move, transport (by saltation and/or creeping), and (re)deposit lithic artifacts bigger than 10 mm. Also, field observations showed that being aware of maximum wind speed value is more informative and useful for our archaeological taphonomic research than annual mean wind speed. This is due to the fact that bursts – regardless their brevity – have the largest impact on surface record since they have the capacity to move larger and heavier materials and/or disrupt stable conditions thus beginning dynamic processes that may lead to the creation of a new stable state.

Overall, these observations emphasize the importance of modeling wind effects on lithic artifact through further actualistic studies to achieve a better understanding of the local surface archaeological record formation (c.f. Borrero, 2011b; Massigoge and González, 2012). Although the need to study the role of wind transport in Patagonia is clear enough, actualistic research in Fuegian steppe may be of much wider relevance for the study of spatial and morphological properties of lithic assemblage in other desert/semi-desert environments.

### 2.2. Methods

In order to assess and begin to gauge the impact of eolian erosion on lithic assemblages, we set a plot with 44 experimental flakes (Table 1). Unlike our previous long term experiments, this plot was designed and set in the field to be surveyed and control on a daily basis for artifact movements and wind speed throughout the experiment duration (11 days).

The plot was located in the north of San Sebastian Bay (Tierra del Fuego, Argentina), on the top of a clay dune devoid of prehistoric artifacts (Vilas et al., 1999; Favier Dubois, 2001; Borrazzo, 2013). The selected spot was smooth, dry, and free of vegetation. Visibility conditions were excellent. It was exposed to the dominant wind (SW) and exhibited a 10° SW slope. Plot included experimental artifacts (flake and debris) produced by free-hand percussion from two nodules of local silicified rocks, one of the most frequent raw materials represented in regional archaeological assemblages. Pieces selected for the experiment exhibited up to 60 mm, as they are the most common sizes recorded among artifact collections in the region (Borrazzo, 2010, 2012). Size categories were assigned by using a 5 mm interval grid (Franco, 2002). Sector A included 10 artifacts of 20–30 mm size (1.28–3.46 g weight or 1344–5152 $mm^3$ volume, Table 1). Sector B was composed of 11 larger pieces, with 35–55 mm size (5.18–31.90 g or 4352–24,576 $mm^3$ volume, Table 1). Pieces in both sectors were set following a linear design, perpendicular to major wind direction, although wind moved some of the experimental artifacts soon after their deposition on the plot (Fig. 1A and E). The position of the ruler was established perpendicular to artifact line and parallel to the slope. It was fixed to the substrate by means of two cloves to facilitate daily controls and ensure accuracy of data collected. All the artifacts were deposited with the ventral surface on the dry substrate and their main axes parallel to the row (Fig. 1).

A third group of 23 smaller artifacts (5–25 mm, $\leq$1.50 g, $\leq$1920 $mm^3$) were deposited on sector C of the plot. In this case, pieces were set clustered in a circular fashion, in random position and orientation, but avoiding physical contact among them.