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# Obsidian geochemistry, geoarchaeology, and lithic technology in northwestern Patagonia (Argentina)

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ABSTRACT

We studied the organization of mobility of hunter-gatherers groups of northwestern Patagonia (Argentina) from an interdisciplinary perspective. We combined geochemical and technological characterization of obsidian assemblages from surface and stratigraphic contexts spanning the Holocene, and a preliminary geoarchaeological study of the sources. The goals were to assess the provenance, mode of supply, use, and discard of obsidian artifacts on the basis of information on the structure of the two main regional sources: Cerro Huenul, located in the lowlands, and Laguna del Maule, located in the Andean highlands. We conducted geoarchaeological field sampling at different altitudes of the Barrancas River fluvial deposits to study the geomorphic impact on the secondary structure of the highland source. Preliminary geoarchaeological results allow extending the area of availability up to 90 km towards the lowlands from the outcrops. In addition, we performed non-destructive XRF analyses on 266 lithic artifacts, which were placed along a continuum of reduction. 89% of the artifacts corresponded to the local Cerro Huenul source, while 11% to Laguna del Maule. While the artifacts made on Cerro Huenul obsidian were represented by the full reduction sequence, those from Laguna del Maule are only represented by advanced stages. We integrate these results with information on the frequencies of projectile points, ceramics, and rock-art motifs for the two main archaeological sites in the region: Cueva Huenul 1 and Cueva Yagui. These proxies indicate that the sites have different place use histories, providing a scheme for the analysis of human use of the regional landscape.

## 1. Introduction: goals and research frame

Spatial organization in mobile societies is a multi-layered phenomenon connecting diverse socio-economic spheres (e.g., Binford, 1980; Kelly, 1995; Marlowe, 2005). An approach to the organization of mobility that combines the geochemical characterization of lithic raw material sources and technological patterns is optimally suited to tackle this issue on an archaeological scale (Jones et al., 2003; Surovell, 2009). Due to its compositional homogeneity, obsidian can be thoroughly characterized using diverse geochemical methods (Glascock, 2002; Shackley, 2005; Rademaker et al., 2013). Geological and geochemical data from available lithic sources provide the frame of reference to assess the provenance of the lithic raw materials of archaeological artifacts. In turn, this allows the assessment of patterns of human mobility, resource provisioning, and the existence of indirect mechanisms involved in raw material acquisition (Hughes, 1998; Kelly, 2011; Renfrew, 1977; Torrence et al., 2013).

The segment of the South American Andes range considered here, between 33° and 38° S (Fig. 1), presents a tectonic history conducive to the formation of obsidian deposits in arc and back-arc settings

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**Fig. 1.** Study area and main obsidian sources between 33° and 38° S.

(Folguera et al., 2008; Kay et al., 2006; Stern, 2004). Coupled with intense glacial and fluvial geomorphic processes occurring during the late Quaternary, which have produced an intense secondary redistribution of obsidian nodules, the landscape of obsidian sources in northwestern Patagonia is complex, constituting both a challenge and an excellent opportunity to reconstruct patterns of human mobility and technological organization at different spatial scales.

In this paper, we present geochemical and technological results for archaeological obsidian assemblages from surface and stratigraphy contexts from northwestern Patagonia (Neuquén Province, Argentina), spanning the Holocene in a discontinuous fashion. These results are interpreted in reference to geological and geochemical information already available for obsidian sources (Durán et al., 2004; Giesso et al., 2011). The interdisciplinary results presented here constitute a step towards unraveling the structure of primary and secondary sources, their geochemical signatures and, on this basis, patterns of human provisioning, use, and discard of lithic artifacts in the heterogeneous landscape of northwestern Patagonia. We suggest that proportions of the different obsidian chemical types in archaeological assemblages provide a local proxy of histories of site use, specifically, intensity of human occupation (Smith, 2011). Building on this, and integrating data on the frequencies of projectile points, ceramics and rock art motifs, we present a preliminary reconstruction of the spatial organization of the mobile societies that inhabited northwestern Patagonia.

## 2. Background: Andes range, study area and obsidian

### 2.1. Andes range: geology and ecology

The Andes mountain range forms a 7500 km long physiographic structure extending along the western margin of South America, from 10° N in Colombia to 53° S in Tierra del Fuego Island (Clapperton, 1993). Volcanic activity is discontinuous along this range, where discrete volcanic zones exhibit different characteristics (Stern, 2004). This research focuses on the southern volcanic zone, between 33° and 38°S (Fig. 1). The type of silicic volcanic activity that is conducive to the formation of obsidian deposits (Cabrera et al., 2011) is restricted to certain segments of the Andes. In this region, Andean obsidian deposits are associated with arc and back-arc settings, presenting varying ages of formation that extend from the late Pliocene to the Holocene (Folguera et al., 2008; Hildreth et al., 2009). Furthermore, these diverse geologic and chronological contexts, and the subsequent action of geomorphic processes produce different types of obsidian sources, from primary outcrops in the Andean highlands to secondary accumulations in ignimbrite deposits and fluvial landforms.

The Andes function as a topographic barrier to the prevailing westerly storm tracks, affecting the patterns of circulation and imposing a steep west-east gradient on precipitation effective moisture (Garreaud et al., 2009). Thus, annual precipitation varies from ca. 1100 mm close to the Chile–Argentina border, to 200–150 mm in the eastern lowlands of Argentina. Vegetation distribution follows the decreasing west-east precipitation gradient, where forest communities west of the Andes (Chile) and in confined Andean slopes of Argentina successively give way to the highland Altoandina phytogeographic province above 2600 masl. Grass and shrub steppes develop as altitude and precipitation decrease towards the eastern Argentinean lowlands with characteristic desert vegetation of the Monte phytogeographic province (Chiapella and Ezcurra, 1999; León et al., 1998).

Northern Neuquén region (Fig. 1), where we focus our research, captures a large part of this landscape variation on a small spatial scale. The western part of the region exhibits relatively high precipitation ($\geq$ 300 mm/year) producing patches of productive grasslands and restricted wetland, which are circumscribed due to the presence of a rugged terrain. This produces seasonally restricted access to highlands located above 1700 masl. The eastern part of the region, on the other hand, displays lower precipitation ($\leq$ 150 mm/year) and a gentler relief, where the proportion of land available for human occupation during winter is comparably higher (Barberena, 2013).