Siltstone from Southern Patagonia: Its Source and Archaeological Artifact Distribution in Santa Cruz Province, Argentina

Juan Bautista Belardi,[1,*] Gisela Cassiodoro,[2] Rafael Goñi,[3] Michael D. Glascock,[4] and Alejandro Súnico[5]

[1]Universidad Nacional de la Patagonia Austral, Unidad Académica Río Gallegos y CONICET, Santa Cruz, Argentina
[2]Instituto Nacional de Antropología y Pensamiento Latinoamericano, Universidad de Buenos Aires y CONICET, Argentina
[3]Instituto Nacional de Antropología y Pensamiento Latinoamericano, Universidad de Buenos Aires, Argentina
[4]University of Missouri, Research Reactor Center, Columbia, USA
[5]Universidad Nacional de la Patagonia Austral, Unidad Académica Río Gallegos, Santa Cruz, Argentina

Correspondence
*Corresponding author: E-mail: juanbautistabelardi@gmail.com

Received
7 April 2014
Revised
2 December 2014
Accepted
5 December 2014

Scientific editing by Steven Shackley

Published online in Wiley Online Library (wileyonlinelibrary.com).

doi 10.1002/gea.21508

Hunter-gatherer mobility and spheres of interaction are important characteristics worthy of investigation in Patagonian archaeology. One way to approach these is by studying the distribution of lithic archaeological materials. Siltstone (*limolite*) artifacts are found along the western strip of southwestern Patagonia, Argentina. Based on geomorphological studies and the high density of archaeological material, a source was located along the western margin of Cardiel Lake. Neutron activation analysis of samples from the source and archaeological sites in several neighboring basins allowed us to model its circulation. Siltstone's archaeological distribution indicates that its regional circulation had a southerly direction dating from the early Holocene. This southern vector shows an important difference when compared to the distribution of obsidian from Pampa del Asador, which has a broader circulation pattern. This could be related to a greater availability of high-quality lithic materials north of the siltstone source. This work also contributes to the construction of a lithic source database for southern Patagonia. © 2015 Wiley Periodicals, Inc.

INTRODUCTION

Important topics in the study of hunter-gatherers in Patagonian archaeology include mobility and interaction spheres. One way to approach these issues is by studying the distribution of lithic archaeological materials (Andrefsky, 1994; Bamforth, 1986; Ericson, 1984; Jones et al., 2003; Wilson, 2007, among others). Lithic materials suitable for knapping, as well as their source identification, are scarce in southern Patagonia, Argentina. This is why the identification of specific lithic sources can be a motivation for discussion when it comes to their use and circulation in the past. One of the most studied lithic raw materials, and one that is clearly related to terrestrial hunter-gatherer systems, is the black obsidian from Pampa del Asador (Espinosa & Goñi, 1999). However, less is known of other lithic material sources in the region.

The study presented here is focused on the western side of Santa Cruz province, a *supra* region 250 km long (north-south) and 120 km wide (east-west) extending from Salitroso-Posadas-Pueyrredón Lakes Basin to the Tar–San Martín Lakes Basin (Figure 1). Lower elevations are dominated by steppe and have an annual precipitation range of 100–270 mm. *Nothofagus* forest occurs at higher elevations in the Andes near the border with Chile. Between steppe and forest is an ecotonal area. Annual precipitation in ecotonal and forest environments ranges 270 to 800 mm.

Archaeological investigations of hunter-gatherer populations in the region have considered the different uses given to basins 250–350 m above sea level (asl), basaltic plateaus over 900 m asl (Goñi, 2000) and forests (Espinosa, 2000). On one hand, the basins (Salitroso-Posadas-Pueyrredón, Cardiel and Tar–San Martín Lakes) had a residential role throughout the year (Belardi et al., 2010; Goñi, 2000), whereas the plateaus (Pampa del Asador/Guitarra, Strobel, Cardiel Chico/San Adolfo) and forests (Parque Nacional Perito Moreno, west of San Martín Lakes basin) were used seasonally and in the context of logistical mobility (Espinosa, 2000; Espinosa,

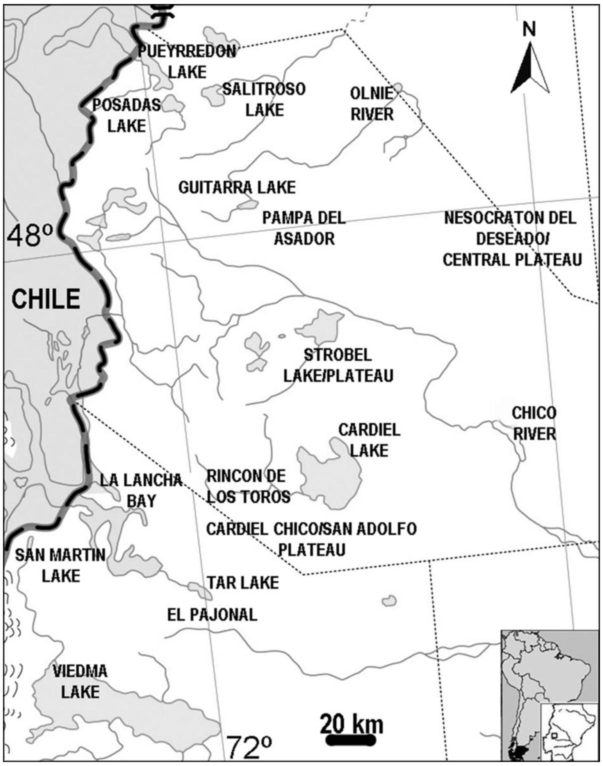

Figure 1 Study region and places mentioned within the text.

Belardi, & Súnico, 2009, Espinosa, Escola, & Belardi, 2013; Goñi, 2000). This model is well supported by archaeological evidence that firmly establishes human occupation in the region by the late Holocene (the last 2500 years), with the earliest evidence dating to the early Holocene (~9700 ^{14}C yr BP) (Aschero, Bellelli, & Goñi, 1992-1993–93; Belardi et al., 2010; Espinosa, Escola, & Belardi, 2013; Goñi et al., 2004).

Hunter-gatherers in Patagonia adapted to post-glacial environmental changes that are recorded in local proxy records. Cardiel Lake, in particular, is an endorheic steppe basin that documents numerous oscillations in climate since the beginning of the Holocene (Ariztegui et al., 2010; Stine & Stine, 1990). Several studies show a period of higher humidity between 11,200 ^{14}C yr BP and 6700 ^{14}C yr BP, and significant variability in moisture during the past ~1900 years. The Cardiel Basin also displays spatial environmental variability including canyons, low plateaus, and dunes along the southern and eastern margins (Belardi et al., 2003; Goñi et al., 2014). Differential use was given to certain areas, as documented by at least two important archaeological data sets: (1) the use of obsidian from Pampa del Asador, and (2) the distribution of rock-engraved motifs from the plateaus (Belardi & Goñi, 2006; Belardi et al., 2009; Goñi et al., 2007; Molinari & Espinosa, 2009; Re, Guichon & Belardi, 2009). Use of the various lake basins, plateaus and forests appears to have been integrated through the circulation of goods, populations, and information (Aunger, 2009; Odling-Smee, Laland, & Feldman, 2003).

At this spatial scale, the mobility and interaction spheres of hunter-gatherers can be investigated by studying other lithic materials suitable for knapping and available in the region such as siltstone—locally known as *limolite*. Naturally occurring deposits and artifacts manufactured from this rock are mainly found along the western margins of Cardiel Lake (Goñi et al., 2005). The aim of this work is to describe the location of the siltstone source, to analyze its geochemical characteristics using neutron activation analysis (NAA), and to evaluate the spatial and temporal distribution of artifacts made from this raw material in order to gain new insights regarding landscape use by southern Patagonian hunter-gatherers.

LITHIC RESOURCES IN THE SUPRA REGION

The *supra* region under study is characterized by lake basins separated by large basaltic plateaus that originated during the Miocene (Figure 1). Local geology presents rocks of varied origins and ages (Giacosa, Franchi & Genini, 1997; Ramos, 1982) overlain by unconsolidated Quaternary glacial, fluvial, and lacustrine deposits. The landscape offers four general types of rocks suitable for tool production from secondary sources (Luedtke, 1979; Nami, 1992).

First, black obsidian from Pampa del Asador stands out as a widely used source (Espinosa & Goñi, 1999). This raw material is of excellent quality for knapping (*sensu* Aragón & Franco, 1997). Artifacts made from Pampa del Asador obsidian has been identified from sites located as far south as Tierra del Fuego (Stern, 2004) and as far north as Península de Valdés (Stern, Gómez Otero, & Belardi, 2000) and west toward the Chilean border (Stern et al., 1995). Throughout the *supra* region obsidian was the preferred raw material used for the manufacture of projectile points (Belardi, Espinosa, & Cassiodoro, 2005; Cassiodoro, 2011, among others).

Second, isolated pebbles of siliceous rocks (e.g., siltstone and flint) are found in the Salitroso-Posadas Lakes basin (Guraieb, 1998) as well as in the Cardiel Lake Basin (Belardi et al., 2003). Siliceous rocks of very good quality for knapping are also present in the Pampa del Asador and San Adolfo plateaus (Belardi et al., 2013; Espinosa & Goñi, 1999). However, usage of this material in different sectors of Central Plateau / Nesocraton del Deseado, located in the eastern portion of the study region, is higher given the greater availability of these rocks (Cattáneo, 2004; Hermo, 2009; Paunero et al., 2004). It is important to note the scarcity of high-quality knapping flint south of the Chico River (Franco et al., 2011). With the exception of Pampa del Asador, artifacts made from flint are most frequent in archaeological assemblages in the region.

Third, basalts are located in the Posadas Lake Basin (Guraieb, 1998), in Bajo Caracoles and the nearby grounds of Olnie river (Belardi & Carballo Marina, 2005), in Pampa del Asador (Espinosa & Goñi, 1999), on the eastern and southern margins of Cardiel Lake (Belardi et al., 2003) and in the San Adolfo Plateau (Belardi et al., 2013). Artifacts made from basalt are found throughout the area of study even though their qualities for knapping vary.

Finally, there are other types of rocks, such as green silicified tuff (Espinosa, Belardi & Súnico, 2009), that have an identified source, located at the isthmus of the Maipu Peninsula (southern shore of the San Martin Lake). However, the distribution of artifacts made from tuff barely extends beyond the area of provenience.

Within this framework of different rocks suitable for knapping is where siltstone is contextualized. The existence of cobbles of this rock along the western margins of Cardiel Lake has already been mentioned (Goñi et al., 2005). They are also found, in small quantities, as angular fragments in rivers and streams coming down from the Cerro Belgrano Plateau toward the Posadas Lake Basin (Guraieb, 1998), or as pebbles along the shores of Guitarra Lake (Goñi et al., 2010). Siltstone was used to manufacture a variety of bifacial and unifacial tools (Figure 2).

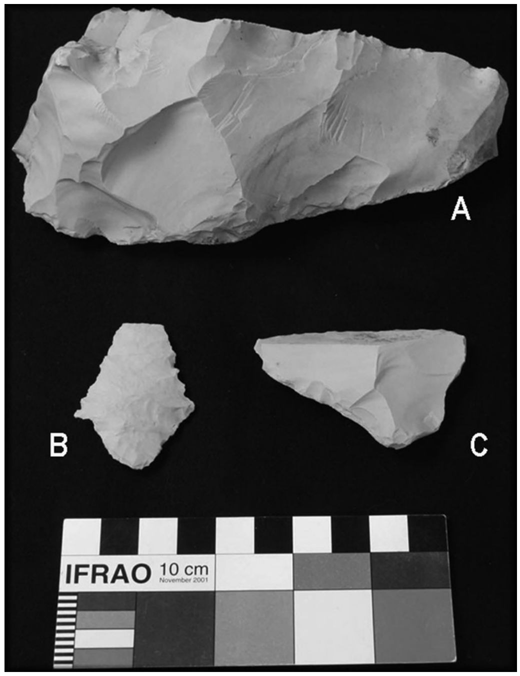

Figure 2 Siltstone artifacts from Cardiel Lake. (A) core, (B) projectile point, (C) low retouch artifact.

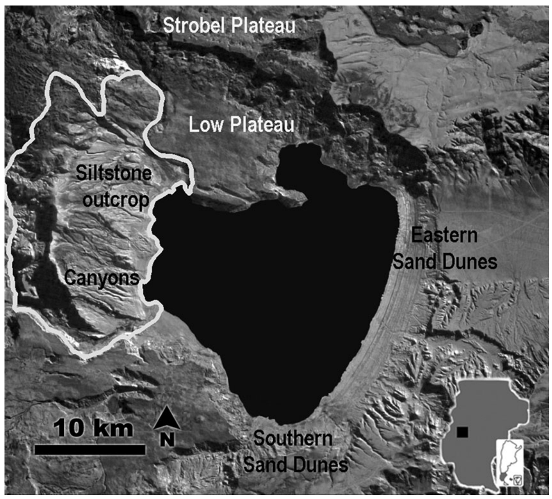

Figure 3 Lake Cardiel Basin and the siltstone source.

SILTSTONE AND ITS SOURCE

Siltstone is a sedimentary clastic rock, composed primarily of silt grains with sizes ranging between 0.062 and 0.004 mm. This type of rock is formed through the processes of cementation and compression of detritic middle-sized particles. Recent articles by Nash et al. (2013a, b) describe a similar type of siliceous rock found in southern Africa widely used during the Middle Stone Age. Given its homogeneity, conchoidal fracture, and size of grains, this raw material represents a high-quality material for knapping (*sensu* Aragón & Franco, 1997). In terms of color, gray tones, light brown and yellowish varieties exist. The gray type commonly contains white dots formed by amorphous silica on its surface (a macroscopic characteristic), a feature particularly useful for identifying siltstone.

The largest quantities of artifacts manufactured from siltstone are found in the Cardiel Lake Basin (Belardi et al., 2003; Goñi et al., 2005; Figures 1 and 3). Since these artifacts are found in the canyons along the western margin of the lake, we focused our assessments of siltstone availability in this area. The main outcrop lithology corresponds to sediments from the Piedra Clavada Formation (Andreis, Zalba, & Morosi, 2007; Feruglio, 1949), which is more than 250 m thick and has a broad distribution. The main lithologies in the lower part of this formation consist of silty sandstones and fine grain siltstones as well as tuffs; the upper part contains a higher

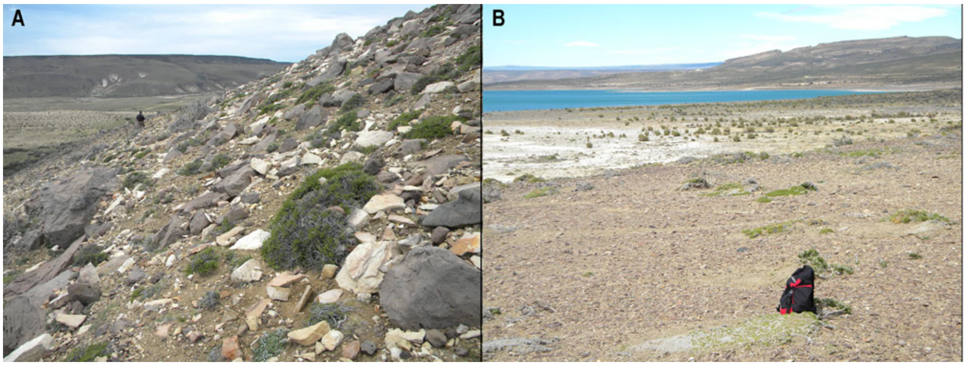

Figure 4 (A) Siltstone outcrop in a canyon adjacent to paleo-beaches at Cardiel Lake. (B) Paleo-beach at Cardiel Lake.

proportion of thickly bedded sandstones and a larger presence of pyroclastic rocks.

Canyons west of Cardiel Lake (Figure 3) are cut into sediments from the Piedra Clavada Formation. These canyons have steep slopes mainly formed in thick yellow sandstone beds. In the valley bottoms, fluvial and aeolian sediments are present as a product of nearby rock erosion. A series of drainages emerge from canyons and form alluvial fans that overlie and are eroded by former shorelines of Cardiel Lake (Figure 3).

Alluvial and beach surface deposits contain a great number of siltstone clasts with lengths ranging 5–15 cm. Clasts are basically prismatic with subrounded edges, a characteristic that indicates short-distance transport from the source area. *In situ* outcrops in beds ranging 40–60 cm are also present west of the lake. All of this leads to abundant availability of siltstone material in different geomorphic contexts along the northwestern margin of the lake: outcrops, alluvial fans, and paleo-beaches (Figure 4).

The siltstone at Cardiel Lake has a fine texture marked by strong silicification and compression which gives it a conchoidal fracture and an amorphous structure favorable for knapping. When disaggregated and observed with a polarized light microscope, these rocks primarily exhibit a quartz composition. Thin-section analysis of seven samples from different Cardiel deposits indicates the presence of silica veins and lack of calcite confirming the materials' homogeneity (Figure 5).

With the aim of evaluating the availability of rocks suitable for knapping, cobbles, and pebbles were collected from the western margin of Cardiel Lake over a ten-minute period. Later, they were counted and their dimensions were measured (Franco & Borrero, 1999). On a lacustrine terrace (shoreline), over a surface area of 128 m^2, a total of 79 siltstone cobbles was recovered. Of these 89.9% were of very good quality (established on the basis of the homogeneity of the raw material and conchoidal fracture pattern) and 8.9% were of satisfactory quality for knapping. The average dimensions of whole cobbles are shown in Table I. Note that cobbles have tabular and prismatic forms (Figure 6).

Frequencies, flaking qualities and sizes confirm the great availability of cobbles suitable for knapping in the canyons along the western margin of Cardiel Lake. Beyond regional geologic mapping, previous studies conducted in the region have not reported other siltstone sources of this magnitude. The fact that this part of Cardiel Lake is the only area where a significant number of siltstone clasts of good knapping quality are present and the particular dimensions of these clasts leads to the conclusion that this area was likely the main source of siltstone for hunter-gatherer groups in the region. Sites with siltstone artifacts showing flintknapping activities (cores and flakes from different types and sizes) are located in more sheltered places along the canyons. Holocene lake level fluctuations (Stine & Stine, 1990) would only affect the availability of cobbles deposited on the shores, while upper terraced levels were always available. As mentioned, siltstone from Posadas and Guitarra Lakes occurs in small quantities at very specific points, and were unlikely to have been significant sources for tool production.

GEOCHEMICAL ANALYSIS

With the aim of determining the characteristics of this raw material and evaluating its distribution, archaeological samples from across the area under investigation were selected. Natural pebbles include not only samples from Cardiel Lake but also from Posadas and Guitarra Lakes (Figure 1; Table II). A total of 70 artifacts and source samples was submitted for NAA at the University of Missouri Research Reactor (MURR).

All samples were prepared by crushing between tool steel plates to produce a large number of small

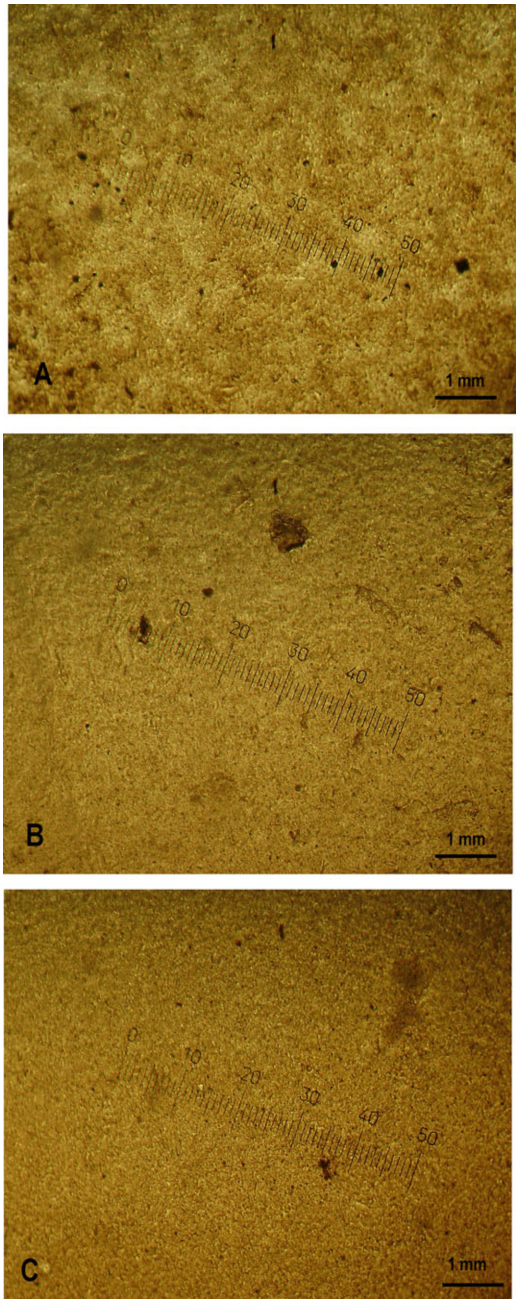

Figure 5 Thin section photomicrograph of samples from Cardiel Lake. (A) coast (sample c), (B) alluvial fan (sample E), (C) alluvial fan near banks (sample B).

fragments 25 mg or smaller. Using a magnifier glass and Teflon tweezers, a number of clean interior fragments were selected for analysis. Samples for short- and long-irradiation methods, as described by Glascock (1992), were prepared by weighing 150 mg of fragments into clean poly vials and 750 mg of fragments into high-purity quartz vials, respectively. Standards were prepared from

Table I Cobble size in canyons on the west side of Cardiel Lake.

Cobbles ($N = 79$)	Length (cm)	Width (cm)	Thickness (cm)
Mean	11.6	6.57	3.24
Standard deviation	2.60	1.56	1.03

powders of SRM-1633b Flyash, SRM-278 Obsidian Rock, and SRM-688 Basalt Rock. All weights were recorded to the nearest 0.01 mg.

Nine elements were measured by gamma-ray spectroscopy after short irradiation: Al, Ba, Ca, Dy, K, Mn, Na, Ti, and V. Twenty-four elements were measured after long irradiation: As, La, Lu, Nd, Sm, U, Yb, Ce, Co, Cr, Cs, Eu, Fe, Hf, Ni, Rb, Sb, Sc, Sr, Ta, Tb, Th, Zn, and Zr. Elemental concentrations were calculated by comparing the decay-corrected ratios of measured counts per second per milligram to the same ratios in standards. Most of the elements measured by NAA have uncertainties on the order of 2–5%. The main exceptions are As, Nd, U, Co, Ni, Sb, Sr, and Zr which have uncertainties ranging from 5–20%.

Most geochemical studies conducted by NAA will generate data for 33 elements. However, it was necessary to eliminate the element Ni from statistical treatment in this study because it was below detection limits for greater than 50% of the siltstone samples. For other elements with missing values (As, Sr, Ti, V, and Zn), replacement values were automatically calculated based on minimizing the change in Mahalanobis distance for that sample from the centroid of the group (Sayre, 1975). Statistical analyses were subsequently carried out on base-10 logarithms of concentrations for the remaining 32 elements. Use of log concentrations rather than raw data compensates for differences in magnitude between the major elements, such as Al, K, and Fe, and trace elements, such as the rare earth elements. Transformation to base-10 logarithms also yields a more normal distribution for the trace elements (Limpert et al., 2001).

The interpretation of compositional data obtained from the analysis of archaeological materials has been discussed in detail elsewhere (e.g., Bishop & Neff, 1989; Glascock, 1992; Neff, 2000). The main goal here is to identify distinct homogeneous groups within the analytical database that can be assumed to represent geographically restricted sources.

Initial hypotheses about source-related subgroups in the compositional data can be derived from non-compositional information (e.g., archaeological context) or by applying various pattern-recognition techniques to the multivariate chemical data. Some of the pattern recognition techniques used to investigate archaeological data sets are cluster analysis (CA), principal

Figure 6 Examples of siltstone cobbles of very good quality for knapping.

Table II Frequencies of archaeological and natural siltstones by region.

	Samples		
Region	Archaeological	Natural	Total
Salitroso Lake	1	–	1
Cerro de Los Indios 1	1	–	1
Pampa del Asador/Guitarra	3	3	6
Strobel Plateau	3	–	3
Cardiel Lake Canyons	8	22	30
Cardiel Lake Sand dunes	3	–	3
Rincón de los Toros	1	–	1
Cardiel Chico Plateau	9	–	9
San Adolfo Plateau	3	–	3
San Martín Lake La Lancha Bay	2	–	2
Tar Lake	7	–	7
El Pajonal (between Tar and Viedma Lakes)	3	–	3
Viedma Lake	1	–	1
TOTAL	45	25	70

components analysis (PCA), and discriminant analysis (DA). Each technique has its own advantages and limitations which may depend upon the types and quantity of data available for interpretation.

The log-transformed siltstone source data were subjected to Ward's method of hierarchical cluster analysis using squared-mean Euclidean distances and single-linkage clustering between samples (Ward, 1983). The resulting tree diagram failed to produce robust sub-groups which suggested that the siltstone source should be considered as having a single compositional fingerprint.

Principal components analysis was also used to examine the total variance with the source dataset and facilitate comparison of the artifacts to the source. The procedure uses an orthogonal transformation to convert a dataset of possibly correlated observations (i.e., elements containing redundant information) into an artificial dataset of linearly uncorrelated variables. The main advantage of PCA is the ability, for small datasets, to reduce the number of variables needed to account for most of the variance in the data. Table III shows the results of PCA based on transformation of the variance-covariance matrix for the first seven principal components (PCs) which subsume more than 91% of the variance. The elements most heavily loaded on the first principal component (PC1) are Mn, Fe, and Co. And, the elements most heavily loaded on the second component (PC2) are As, Ca, Sr, and Ba.

Figure 7 shows a biplot of the variance-covariance structure of the source data based on the first two principal components (PCs). The source samples are surrounded by a 90% confidence ellipse. Vectors indicating the direction and strength of individual elements relative

Table III Loading factors and percentage variance explained by the first seven principal components after applying PCA to the variance-covariance matrix for the siltstone source specimens.

Element	PC1	PC2	PC3	PC4	PC5	PC6	PC7
Mn	**0.540**	−0.054	0.292	−0.172	**0.466**	**−0.401**	0.155
As	0.061	**0.516**	0.297	0.243	0.146	**0.376**	−0.194
Ca	0.262	**−0.422**	−0.066	0.040	−0.127	−0.108	**−0.559**
Sr	0.148	**−0.439**	0.251	**0.364**	−0.018	**0.342**	0.037
Ba	0.142	**−0.332**	−0.116	0.106	**0.460**	**0.400**	0.033
Zn	0.276	0.083	**−0.314**	−0.267	−0.058	**0.464**	−0.133
Cr	0.052	−0.106	−0.095	−0.222	−0.228	0.198	**0.542**
Fe	**0.361**	**0.313**	0.160	−0.013	−0.293	0.046	−0.265
Co	**0.333**	0.070	**0.418**	−0.051	−0.142	0.079	0.223
Na	0.283	−0.016	−0.287	0.131	−0.242	−0.233	0.009
Cs	0.229	0.084	**−0.351**	−0.271	0.151	0.048	−0.049
Sb	0.149	0.272	−0.205	0.161	0.116	−0.068	0.138
U	0.071	0.126	−0.260	0.107	0.120	0.068	0.018
La	0.034	−0.005	−0.050	**0.303**	−0.126	−0.043	0.038
Nd	0.041	−0.008	−0.038	0.278	−0.111	−0.074	0.106
V	0.077	−0.017	0.063	−.197	−0.233	0.056	−0.011
Ce	0.038	−0.001	−0.051	0.291	−0.098	−0.051	0.055
Sm	0.056	−0.007	−0.060	0.261	−0.093	−0.052	0.082
K	−0.062	0.082	−0.045	0.127	0.237	−0.042	0.077
Eu	0.064	−0.021	0.018	0.042	−0.139	0.103	0.199
Rb	−0.028	0.102	−0.102	0.092	0.207	−0.033	0.010
Sc	0.153	−0.032	−0.075	−0.002	−0.097	−0.089	0.157
Tb	0.096	0.021	−0.057	0.185	−0.043	−0.067	0.106
Dy	0.087	0.036	−0.126	0.176	0.012	−0.020	0.075
Ta	0.089	0.048	−0.110	0.108	−0.032	−0.106	−0.111
Zr	0.088	0.034	−0.109	0.035	−0.042	0.095	0.157
Th	0.085	0.052	−0.149	0.104	0.040	−0.001	−0.061
Ti	0.056	−0.043	0.051	−0.055	−0.144	0.107	0.014
Lu	0.073	0.043	−0.104	0.130	0.027	0.009	0.049
Yb	0.076	0.037	−0.089	0.136	0.008	0.013	0.042
Hf	0.104	−0.009	−.048	0.022	−0.058	0.065	0.106
Al	0.057	−0.010	−0.018	0.015	−0.051	−0.045	0.060
% Variance explained	41.7	15.7	12.3	8.4	6.9	3.6	2.8

Loading factors with absolute values greater than 0.3 are shown in bold.

to each PC are also shown. The overall lack of patterning between individual samples can be interpreted as confirming the results of CA results such that the source is best described by a single fingerprint.

Figure 8 shows a scatter plot of the archaeological samples projected against the source data. The vast majority of artifacts are closely associated with the source data supporting the probability that the artifacts are likely to have originated from the source. Mahalanobis distance calculations of principal components scores using the first seven principal components determined that all of the artifacts in this study have membership probabilities of 5% with the source group. Means and standard deviations for the source specimens and artifacts are compared in Table IV.

The applied geochemical methodology does not discriminate between the sources because there is insufficient geochemical variability between sedimentary basins, in particular, within similar stratigraphic levels. Therefore, the macroscopic information (e.g., white dots on the cobbles' surfaces due to the presence of amorphous silica) together with the archaeological evaluation is still important as a complement to the geochemical analysis. Based on this, it can be assumed that siltstones collected in Guitarra plateau and Salitroso-Posadas Lakes basin are distinct from the Cardiel Lake source. Although they are geochemically similar, they are available locally as isolated cobbles.

DISTRIBUTION OF SILTSTONE ARTIFACTS

The geochemical results must be complemented with an evaluation of the distribution of siltstone artifacts in space and time. With regard to spatial scale, a

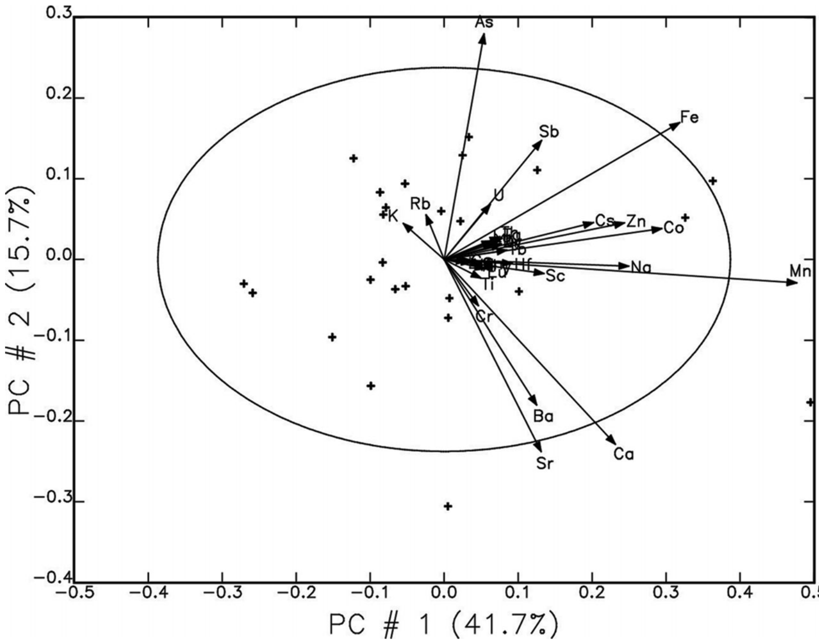

Figure 7 Biplot of principal components 1 and 2. Vectors indicate the direction and magnitude of each element and its contribution on each of the axes. A 90% confidence ellipse surrounds the source group.

relationship has been observed between distance to the source and frequency of debitage, cores and artifacts. In order to evaluate this, different archaeological assemblages from stratified and open air sites and transects, grouped by geographical proximity, were considered together (Figure 1; Table V).

This study shows a predominant use of siltstone around the source (canyons) and its contiguous area (lower plateau) and a considerable decrease inside the Cardiel Lake Basin, eastwards, northwards, and southwards from the lake. At the same time, the low frequencies at Posadas and Guitarra Lakes support the limited role played by their siltstone deposits. Furthermore, there is an

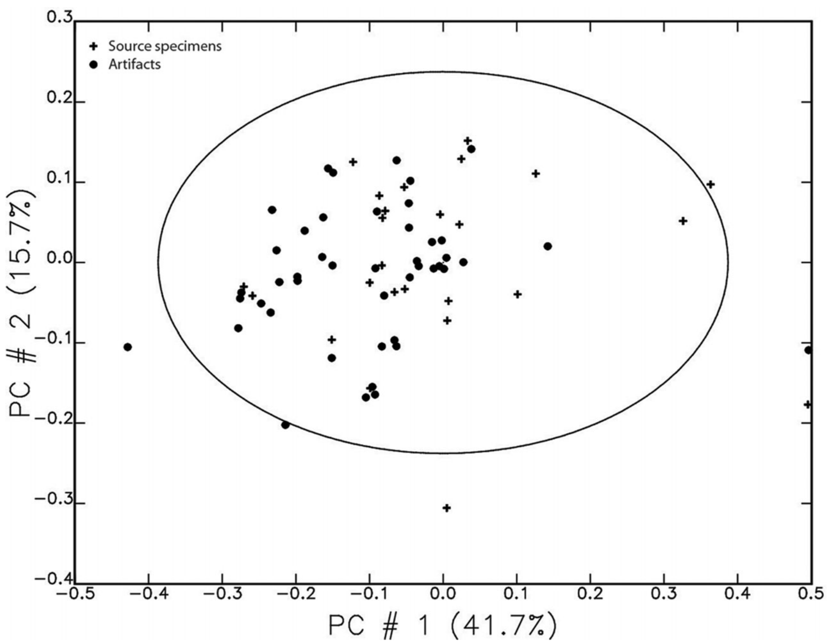

Figure 8 Scatter plot of artifacts projected against the source group on principal components 1 and 2.

Table IV Comparison of element means and standard deviations (SD) for source specimens and artifacts.

Element	Siltstone source and artifacts ($n = 70$) Mean ± SD
Na	2052 ± 2539
Al (%)	4.43 ± 1.00
K (%)	4.68 ± 1.33
Ca	2277 ± 3047
Sc	5.25 ± 2.59
Ti	2434 ± 663
V	15.3 ± 10.4
Cr	2.70 ± 1.59
Mn	129 ± 405
Fe	4535 ± 6794
Co	0.77 ± 1.28
Zn	16.0 ± 13.3
As	5.76 ± 5.30
Rb	125 ± 35
Sr	68 ± 119
Zr	75 ± 30
Sb	0.56 ± 0.77
Cs	1.83 ± 1.44
Ba	632 ± 821
La	17.9 ± 7.4
Ce	38.2 ± 15.3
Nd	17.8 ± 7.3
Sm	3.96 ± 1.58
Eu	0.70 ± 0.39
Tb	0.57 ± 0.20
Dy	3.43 ± 1.32
Yb	2.54 ± 0.73
Lu	0.37 ± 0.11
Hf	2.99 ± 0.96
Ta	0.48 ± 0.16
Th	8.39 ± 2.95
U	2.31 ± 1.37

important difference in the diminished siltstone frequencies north and south of the canyons with even lower frequencies toward the north. In addition, its use in the south continues to decrease toward the west and closer to the upland forests, as in the case of the Tar–San Martin Lakes Basin. In all cases, the frequencies of siltstone in all sectors, including to the north of Cardiel Lake, are statistically distinct from sectors to the south (Table VI).

The distance to the source is the first criterion for evaluating raw materials variation in the archaeological record. Therefore, the information shown on Table V is displayed as a chart showing approximate distances between regions and the Cardiel Lake canyons. As previously mentioned, different artifacts present the same tendency: a decrease in number as the distance from the source increases (Renfrew, 1977). On the whole, there are greater numbers of siltstone pieces in sectors located south from canyons.

The high percentage of debitage in canyons surrounding Cardiel Lake (Figure 9) coincides with activities related to nearby quarries and/or workshops. Nevertheless, there are differences in the percentages of debitage with cortex along Lake Cardiel (around 30% in the southern dunes and 5.5% in the canyons). Multiple factors may be acting, such as blank transportation and differential landscape use. Accounting for these aspects would require a specific debitage analysis that exceeds the objectives of this study. However, we emphasize that the percentage of debitage with cortex in the Cardiel Basin is higher than those recorded in regions to the north (around 3% in the Strobel Plateau) and south (less than 2%).

The high percentage of cores in Cardiel Lake canyons (Figure 9) coincides with activities related to quarries and/or workshops, although their discard has sometimes occurred in sectors within the Tar–San Martin Lakes Basin. Formal tools may have been transported and discarded in places far from where they were manufactured.

Examining the differences in siltstone frequency between the eastern sand dunes and northern margin of San Martín Lake, Tar Lake, Cardiel Chico Plateau, and San Adolfo Plateau, we propose that these data highlight the natural routes for the circulation of populations (Belardi et al., 2009). Tar Lake's eastern shore and San Martín Lake's northern shore are the areas from the south that show the highest concentrations of siltstone artifacts. Both of them are accessible from Cardiel Lake by crossing the Cardiel Chico and San Adolfo plateaus (Figure 1).

The tool types produced with siltstone are also relevant (Figure 2). Briefly, siltstone was used to produce a great variety of tools ($n = 190$) where pieces with low retouch are included (51%) and bifacial tools (10.5%). Within these, two stemless projectile points from the canyons stand out and a contracting stemmed point in the canyons (Belardi, Espinosa, & Cassiodoro, 2005). Bearing in mind that this design has been recorded in northern Patagonia, this space has been suggested as a potential circulation and transit zone (Goñi et al., 2005).

At the same time, in many of the assemblages siltstone was used to manufacture side scrapers (25.7%)—mainly in the Cardiel Lake area and the Tar–San Martín Basin. If these quantities are compared to knives (7.3%), selection of this raw material for the manufacturing of long cutting edges may have been possible. Broadly speaking, these pieces range from large (8.1–12 cm) to very large (>12 cm). The choice of nodule size to manufacture these items may have been privileged because of the prismatic and tabular characteristics of siltstone nodules.

With regard to a temporal scale, information about earlier assemblages where siltstone artifacts have been reported is presented in Table VII. The radiocarbon dates

Table V Percentages of siltstone artifacts in relation to artifacts of all raw materials found (Belardi et al., 2009, 2010, 2013; Cassiodoro, 2011; Espinosa, Goñi, & Flores Coni, 2007; Flores Coni, 2013; Goñi et al., 2010; Guráieb, 1998).

	Debitage / flakes		Cores		Tools	
Region / sectors	% siltstone	total raw materials	% siltstone	total raw materials	% siltstone	total raw materials
North of Cardiel Lake						
Posadas Lake	0.80 ($n = 92$)	11	1.60 ($n = 1$)	63	1.80 ($n = 38$)	2064
Salitroso Lake	0.48 ($n = 31$)	6423	0.43 ($n = 1$)	231	1.07 ($n = 7$)	1306
Guitarra Plateau	0.15 ($n = 3$)	2011	0	49	0.81 ($n = 2$)	246
Pampa del Asador	0	13	0	89	1.90 ($n = 5$)	263
Strobel Plateau	0.58 ($n = 33$)	5630	0	5	2.27 ($n = 2$)	88
Cardiel Lake						
Canyons	50.10 ($n = 714$)	1425	56.50 ($n = 13$)	23	26.37 ($n = 24$)	91
Lower Plateau	24.00 ($n = 258$)	1075	20.83 ($n = 10$)	48	22.59 ($n = 40$)	177
Eastern Sand dunes	7.16 ($n = 112$)	1563	7.24 ($n = 5$)	67	5.37 ($n = 8$)	149
Southern Sand Dunes	6.93 ($n = 56$)	808	3.45 ($n = 1$)	29	5.75 ($n = 8$)	139
South of Cardiel Lake						
Cardiel Chico-San Adolfo Plateaus	2.80 ($n = 15$)	534	0	8	5.60 ($n = 21$)	375
Tar Lake East and Southeast Margins	5.71 ($n = 16$)	280	14.28 ($n = 5$)	35	5.20 ($n = 5$)	96
San Martín Lake North Margin	9.55 ($n = 28$)	293	15.38 ($n = 26$)	26	10.35 ($n = 338$)	338
San Martin Lake South Margin	0.85 ($n = 13$)	1516	3.22 ($n = 1$)	31	3.26 ($n = 5$)	153
San Martín Lake West Margin	1.98	1312	0	68	1.94 ($n = 3$)	154

are considered as minimum ages for the use of this rock. On the whole, the use of siltstone is coincident with the earliest occupation of the Cardiel Lake Basin (6000 ^{14}C yr BP), and close to that of the Tar–San Martin Lakes Basin (8000 ^{14}C yr BP). With reference to the latter, it is important to highlight the existence of stemless projectile points in Cardiel Lake Basin, a design linked to the earliest periods of occupation in Patagonia (Gradin, Aschero, & Aguerre, 1976). Likewise, the occurrence of side scrapers over bifaces manufactured from siltstone in the Tar–San Martín Lakes Basin is also important given the fact that this design was already in use for about 8000 years in Macizo Central (Espinosa et al., 2013; Figure 1).

DISCUSSION AND CONCLUSIONS

Based on geomorphological investigations and the high density of archaeological material, the source of siltstone in our study area has been identified in the canyons along the western margin of Cardiel Lake. A geochemical study of siltstone samples from both the source and archaeological sites in several neighboring basins permits tracing the use of this rock and modeling its circulation. Geochemical studies involving the provenance of sedimentary rocks are scarce (Cackler et al., 1999; Lyons, Glascock & Mehringer, 2003; Nazaroff et al., 2013) and almost nonexistent in southwestern Patagonia (Franco, 2002). For this reason, the present work contributes by not only providing more information about lithic sources in Southern Patagonia but also by describing the geological and geochemical aspects of a specific provisioning source.

At a *supra* regional level, siltstones available in Posadas and Guitarra Lakes were unable to be discriminated from those in the Cardiel Lake Basin through NAA. It should not be considered unusual that this geochemical analysis cannot distinguish between siltstone from different basins, given the fact that sedimentary rocks often exhibit a high degree of homogeneity over large areas. This does not mean the method is useless, however, since it does allow the confirmation of a relationship between

Table VI Chi² values for the comparison between siltstone artifacts from the north (Posadas and Salitroso Lakes and Guitarra, Pampa del Asador and Strobel plateaus), south (Tar and San Martín Lakes and Cardiel Chico-San Adolfo plateaus), and Cardiel Lake canyons.

North vs South	Degrees of Freedom	Chi²	P Value (Chi²)	*P* Value (Fischer)
Debitage	1	255.940	1.316e-57	4.9361e-36
Cores	1	18.845	1.4177e-05	8.4947e-05
Tools	1	76.806	1.8863e-18	2.2228e-15

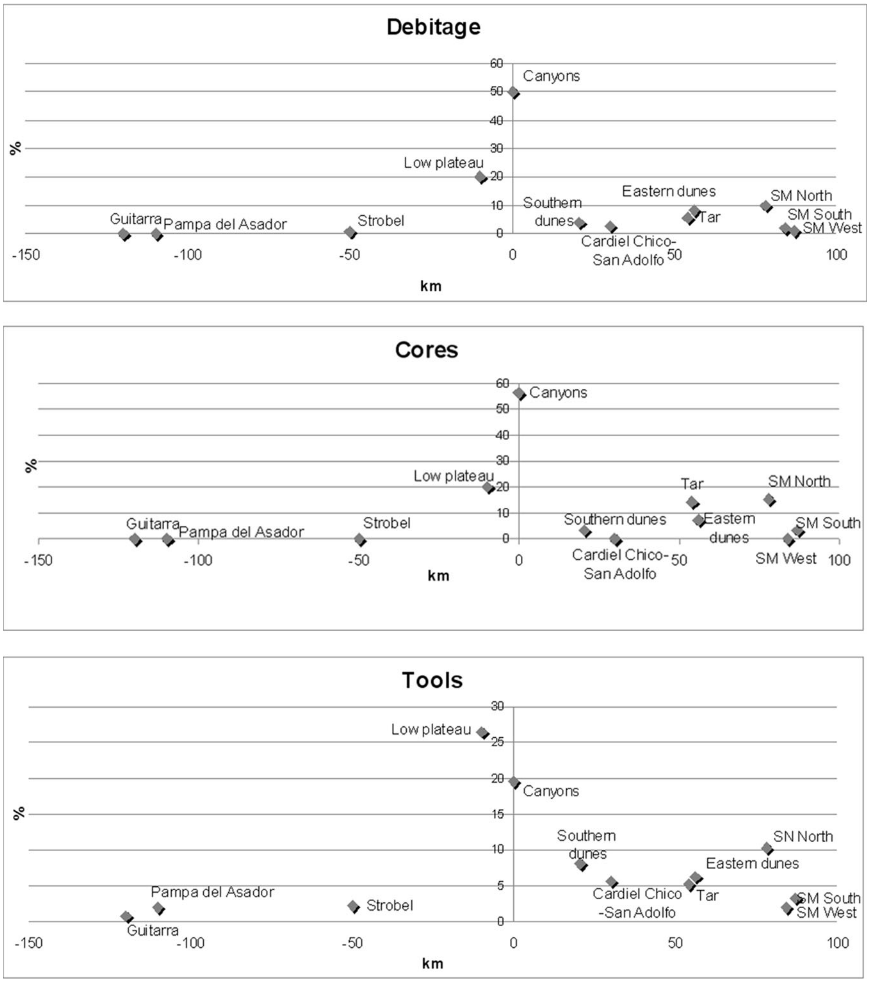

Figure 9 Percentage representation of debitage, cores and tools related to siltstone source distance.

archaeological samples and the source. The implementation of different type of analysis, such as Fourier Transform Infrared Spectroscopy (Parish et al., 2013) or X-ray diffraction, may clarify some of these issues by a mineralogical identification.

In a complementary analysis involving spatial density and macroscopic characteristics, we are able to highlight the deposits from the canyons sector of Cardiel Lake Basin, not only as a provisioning source of siltstone for this basin, but also for the Strobel, San Adolfo and Cardiel Chico plateaus, and the Tar and San Martín Lakes Basin. Petrographic and geochemical homogeneous signals help generate implications for hunter-gatherer mobility from the distribution of archaeological record. Thus, when evaluating the regional distribution of artifacts manufactured from this siltstone, mobility and routes of

Table VII Radiocarbon chronology (not calibrated) of first evidence for use of siltstone.

	Site	Radiocarbon Age (yr BP)	References
Cardiel Lake Basin	Los Guanacos Rockshelter	6000	Goñi et al. (2014)
	Manuk 1	6000	Goñi et al. (2004)
Tar–San Martin Lakes Basin	Paisano Desconocido Rockshelter	<4720	Espinosa et al. (2013)
	Paisano Desconocido Cave	8000	Espinosa et al. (2013)
	Bloque 1-Oquedad	>3770	Belardi et al. (2010)

circulation of goods and populations can be established, which include the Cardiel Lake Basin. The existence of available good quality raw material for knapping could be one of the many incentives for human use of this lake basin. Siltstone was used by hunter-gatherer groups since the earliest days of occupation of Cardiel Lake Basin and probably in the Tar–San Martin Lakes Basin. Black obsidian from Pampa del Asador (Molinari & Espinosa, 1999) was likely circulated by the same populations.

The large quantities of siltstone documented in the Cardiel Lake Basin are evidence of provisioning and local use, primarily in the canyons. The material was used to produce artifacts with long cutting edges as well as other artifact types.

As for the provisioning and circulation characteristics, these may be studied from different scales and perspectives. The frequencies of artifacts and the distributional evaluation support the direct provisioning of siltstone and an important decrease in its use outside the area of the canyons at Cardiel Lake. Toward the north of Cardiel Lake it only reaches the Strobel Plateau in small amounts, as the Guitarra and Posadas samples correspond to different siltstone deposits from the ones in the canyons sector of Cardiel Lake. However, its major representation is in assemblages located south of Cardiel Lake reaching as far south as Viedma Lake (Figure 1) and allows us to detect a southern vector for siltstone circulation, ever since the early occupation periods. Viedma Lake siltstone artifact numbers are negligible, and thus the Tar–San Martín Lakes Basin was likely the southernmost place within the main siltstone circulation sphere. It is also notable that within the Tar–San Martín Basin siltstone also circulated toward the west, as demonstrated by where it is found well into the forest.

From a geographic perspective, the difference is remarkable compared to the distribution of obsidian from Pampa del Asador which shows a broader circulation pattern. As mentioned earlier, obsidian was the most commonly used raw material for manufacturing projectile points in all of the regions studied. Given the importance of projectiles points for the survival of hunter- gatherer populations, the provisioning of obsidian must have been planned, if not scheduled (Knell & Hill, 2012). Because these plateaus are inaccessible during winter, the concomitant circulation of this rock would have been mainly during spring and summer. This is not the case with siltstone, as its distribution and regularity of use is clearly minor and local compared to obsidian.

The reduced frequency of circulation for siltstone to the north may be related to the greater availability of high quality rocks in that region. Northern areas contain not only an obsidian quarry but also scattered siltstone, basalt and chert cobbles. Each material has different knapping qualities. The area is also closer to the Nesocraton del Deseado, where high quality chert is broadly available.

While there was a greater circulation of siltstone toward the south, it does not mean that this was the most frequently used rock (Belardi et al., 2010; Espinosa, Escola & Belardi, 2013). Siltstone may have been incorporated into the repertoire of rocks used in the context of an embedded provisioning strategy (Binford, 1979) together with obsidian. This may have been due to the location of Cardiel Lake canyons located halfway between the Pampa del Asador obsidian source and the Tar–San Martin Lakes Basin. It is very unlikely that groups with well-organized mobility circuits would have ignored a provisioning source of good quality lithic material if they knew about its existence. It is likely that groups would have sought to reduce risk by trying to include all the resources available within their north-south range (Burke, 2006). Thus, this work suggests that the low rates of siltstone transport are related to the priority given to obsidian, and possibly, to other siliceous rocks from the Macizo Central.

In a complementary way, the populations occupying Cardiel Lake would have used Cardiel Chico and San Adolfo plateaus as areas for hunting and circulation. This use of plateaus from the Cardiel Basin could have involved provisioning and direct transfer of siltstone independently from obsidian. A similar strategy may have been implemented in connection with the high plateaus located north of Cardiel's canyons, such as the Strobel Plateau.

Our geological and geochemical analysis of siltstone contributes to the lithic source database for Southern Patagonia. Descriptions of a sedimentary provisioning source presented here will enable further studies on hunter-gatherers' resource selection strategies (Wilson, 2007). Moreover, when related to the archaeological record, this information provides insight into regional provisioning and use strategies.

In conclusion, studies of lithic raw materials in Southern Patagonia helps us to understand the dynamics of land use through time involving circuits of human mobility in a large and geomorphically diverse area. This approach complements lines of analysis such as obsidian provenance and rock engravings distributions, by allowing further evaluation hunter-gatherer mobility during the Holocene. Finally, it helps define the circulation paths for goods and people, and ultimately, the manner in which niche constructions were made.

We would like to thank the owners and the staff of the estancias (ranches) where we carried out our research, especially to the Nuevo family from Estancia Las Tunas. We would also like to thank Josefina Flores Coni for her help with the Spanish-to-English translation and Drs. Gabriela Guraieb, Flavia Carballo Marina, Karen Borrazzo and Damián Bozzuto for reading the

manuscript and contributing with useful comments. Finally, we thank and acknowledge comments and suggestions provided by both reviewers that helped us to improve the manuscript as well as our ideas.
This work was made possible with the contribution of the following projects: PICT 2004 26295 and PICT 2008-1389 and 1247 (Agencia Nacional de Promoción Científica y Tecnológica -ANPCyT), PIP 0122, 0418 and 622 (Consejo Nacional de Investigaciones Científicas y Técnicas -CONICET), PIP 29/A304 (Universidad Nacional de la Patagonia Austral) and UBACYT 2011-2014 W00441. Chemical analysis at MURR was supported by a grant from the US National Science Foundation (DBS-1110793).

REFERENCES

Andrefsky, W. (1994). Raw material availability and the organization of technology. American Antiquity, 59(1), 21–34.

Andreis, R., Zalba, P., & Morosi, M. (2007). Composition and diagenetic processes of sandstone and tuff deposits of the cenomanian Cardiel formation, Cardiel Lake area, province of Santa Cruz. Revista de la Asociación Geológica Argentina, 62, 257–266.

Aragón, E., & Franco, N. (1997). Características de rocas para la talla por percusión y propiedades petrográficas. Anales del Instituto de la Patagonia, 25, 187–199.

Ariztegui, D., Gilli, A., Anselmetti, F., Goñi, R., Belardi, J., & Espinosa, S. (2010). Lake-level changes in central Patagonia (Argentina): Crossing environmental thresholds for Lateglacial and Holocene human occupation. Journal of Quaternary Science, 25, 1092–1099.

Aschero, C., Bellelli, C., & Goñi, R. (1992-1993). Avances en las investigaciones arqueológicas del Parque Nacional Perito Moreno (Provincia de Santa Cruz, Patagonia Argentina). Cuadernos del Instituto Nacional de Antropología y Pensamiento Latinoamericano, 14, 143–170.

Aunger, R. (2009). Human communication as Niche construction. In S. Shennan (Ed.), Pattern and process in cultural evolution (pp. 33–43). Berkeley: University of California Press.

Bamforth, D. (1986). Technological efficiency and tool curation. American Antiquity, 51, 38–50.

Belardi, J.B., & Carballo Marina, F. (2005). Canteras taller de basalto en la zona de Bajo Caracoles-Río Olnie (Provincia de Santa Cruz). Intersecciones en Antropología, 5, 223–226.

Belardi, J.B., Carballo Marina, F., Bourlot, T., & Re, A. (2009). Paisajes arqueológicos, circulación e interacción en diferentes escalas: Una perspectiva desde el lago Tar (Provincia de Santa Cruz). In M. Salemme, F. Santiago, M. Álvarez, E. Piana, M. Vázquez, & E. Mansur (Eds.), Arqueología de la Patagonia: Una mirada desde el último confín (pp. 219–231). Ushuaia: Editorial Utopías.

Belardi, J.B., Espinosa, S., Barrientos, G., Carballo Marina, F., Re, A., Campan, P., Súnico, A., & Guichon, F. (2013). Las mesetas de San Adolfo y Cardiel Chico: Estrategias de movilidad y tácticas de caza de guanacos en el SO de Santa Cruz. In F. Zangrando, R. Barberena, A. Gil, G. Neme, M. Giardina, L. Luna, C. Otaola, L. Paulides, L. Salgan, & A. Tívoli (Eds.), Tendencias teórico-metodológicas y casos de estudio en la arqueología de Patagonia (pp. 261–270). Buenos Aires: Museo de Historia Natural de San Rafael, SAA e INAPL.

Belardi, J.B., Espinosa, S., Carballo Marina, F., Barrientos, G., Goñi, R., Súnico, A., Bourlot, T, Pallo, C., Tessone, A., García Guraieb, S., Re, A., & Campan, P. (2010). Las cuencas de los lagos Tar y San Martín (Santa Cruz, Argentina) y la dinámica del poblamiento humano del sur de Patagonia: Integración de los primeros resultados. Magallania, 38(2), 137–159.

Belardi, J.B., Espinosa, S., & Cassiodoro, G. (2005). Un paisaje de puntas: Las cuencas de los lagos Cardiel y Strobel (provincia de Santa Cruz, Patagonia argentina). Revista Werken, 7, 57–76.

Belardi, J.B., & Goñi, R. (2006). Representaciones rupestres y convergencia poblacional durante momentos tardíos en Santa Cruz (Patagonia argentina). El caso de la meseta del Strobel. In D. Fiore y M. Podestá (Eds.), Tramas en la piedra. Producción y usos del arte rupestre (pp. 85–94). Buenos Aires: World Archaeological Congress, SAA y AINA.

Belardi, J.B., Goñi, R., Bourlot, T., & Aragone, A. (2003). Paisajes arqueológicos en la cuenca del Lago Cardiel (Provincia de Santa Cruz, Argentina). Magallania, 31, 95–106.

Binford, L. (1979). Organization and formation processes: Looking at curated technology. Journal of Anthropological Research, 35(3), 255–273.

Bishop, R.L., & Neff, H. (1989). Compositional data analysis in archaeology. In R. O. Allen (Ed.), Archaeological chemistry IV: Advances in chemistry series No. 220 (pp. 57–86). Washington, DC: American Chemical Society.

Burke, A. (2006). Paleoindian ranges in northeastern North America based on lithic raw materials sourcing. In C. Bressy, A. Burke, P. Chalard, & H. Martin.(Eds.), Notions de territoire et de mobilité. Exemples de l'Europe et des premières nations en Amérique du Nord avant le contact européen (pp1-14). Lyon: Actes de sessions présentées au Xe Congrès Annuel de l'Association Européenne des Archéologues.

Cackler, P., Glascock, M., Neff, H., Iceland, H., & Pyburn, K. (1999). Chipped stone artefacts, source areas, and provenance studies of the Northern Belize Chert-bearing Zone. Journal of Archaeological Science, 26, 389–397.

Cassiodoro, G. (2011). Movilidad y uso del espacio de cazadores-recolectores del Holoceno tardío: Estudio de la variabilidad del registro tecnológico en distintos ambientes del noroeste de la provincia de Santa Cruz. South American Archaeology Series 13. British Archaeological Reports, Oxford.

Cattáneo, R. (2004). Desarrollo metodológico para el estudio de fuentes de aprovisionamiento lítico en la meseta central santacruceña, Patagonia argentina. Estudios Atacameños, 28, 105–119.

Ericson, J. (1984). Toward the analysis of lithic reduction systems. In J. Ericson, & B. Purdy (Eds.), Prehistoric quarries and lithic production (pp. 11–22), Cambridge: Cambridge University Press.

Espinosa, S. (2000). Los conjuntos artefactuales líticos de la estepa y el bosque en el Parque Nacional Perito Moreno (Santa Cruz, Argentina). Desde el País de los Gigantes. Perspectivas arqueológicas en Patagonia (pp. 357–367). Río Gallegos: Universidad Nacional de la Patagonia Austral.

Espinosa, S., Belardi, J., Barrientos, G., & Carballo Marina, F. (2013). Poblamiento e intensidad de uso del espacio en la cuenca del lago San Martín (Patagonia argentina): Nuevos datos desde la margen norte. Comechingonia, 17(1), 105–121.

Espinosa, S., Belardi, J., & Súnico, A. (2009). Cuan al oeste? Arqueología del istmo de la península Maipú (lago San Martín, provincia de Santa Cruz) en su contexto regional. Arqueología, 15, 187–205.

Espinosa, S., Escola, P., & Belardi, J. (2013). Filos largos, piezas bifaciales y diseños en las cuencas de los lagos Tar y San Martín (Santa Cruz, Argentina). In F. Zangrando, R. Barberena, A. Gil, G. Neme, M. Giardina, L. Luna, C. Otaola, L. Paulides, L. Salgan, & A. Tívoli (Eds.), Tendencias teórico-metodológicas y casos de estudio en la arqueología de Patagonia (pp. 343–350). Buenos Aires: Museo de Historia Natural de San Rafael, SAA e INAPL.

Espinosa, S., & Goñi, R. (1999). Viven! Una fuente de obsidiana en la Pcia. de Santa Cruz. In Soplando en el Viento. Actas de las III Jornadas de Arqueología de la Patagonia (pp. 177–188). Neuquén: INAPL-UN de Comahue.

Espinosa, S., Goñi, R., & Flores Coni, J. (2007). Aproximación tecnológica al uso de pampas y bajos en la meseta del lago Strobel (Santa Cruz, Argentina). In M. Salemme, F. Santiago, M. Álvarez, E. Piana, M. Vázquez, & E. Mansur (Eds.), Arqueología de Patagonia: Una mirada desde el último confín (pp. 977–984). Ushuaia: Editorial Utopías.

Feruglio, E. (1949). Descripción geológica de la Patagonia. Dirección General de Yacimientos Petrolíferos Fiscales, 1(15), 1–334.

Flores Coni, J. (2013). La utilización de las mesetas durante el Holoceno tardío: Análisis de la tecnología lítica del sitio Laguna del Faldeo Verde (Meseta del lago Strobel, provincia de Santa Cruz). Unpublished Degree's thesis, Universidad de Buenos Aires, Buenos Aires, Argentina.

Franco, N. (2002). Estrategias de utilización de recursos líticos en la cuenca superior del río Santa Cruz. Unpublished doctoral dissertation, Universidad de Buenos Aires, Buenos Aires, Argentina.

Franco, N., Ambrústolo, P., Skarbun, F., Cirigliano, N., & Martucci, M. (2011). El macizo del Deseado como fuente de aprovisionamiento de rocas silíceas. Variaciones en disponibilidad y circulación: Algunos ejemplos. Cazadores Recolectores del Cono Sur. Revista de Arqueología, 5, 81–95.

Franco, N., & L. Borrero (1999). Metodología de análisis de la estructura regional de recursos líticos. In C. Aschero, M. Korstanje, & P. Vuoto (Eds.), Los tres reinos: Prácticas de recolección en el cono sur de América (pp. 27–37). Tucumán: Instituto de Arqueología y Museo, FCN e IML – UNT, Ediciones Magna Publicaciones.

Glascock, M.D. (1992). Characterization of archaeological ceramics at MURR by neutron activation analysis and multivariate statistics. In H. Neff (Ed.), Chemical characterization of ceramic pastes in archaeology (pp. 11–26). Madison: Prehistory Press.

Giacosa, R., Franchi, M., & Genini, A. (1997). Hojas geológicas 4772-III Lago Belgrano y 4772-IV Lago Posadas, provincia de Santa Cruz. SEGEMER-IGRM.

Goñi, R. (2000). Arqueología de momentos históricos fuera de los centros de conquista y colonización: Un análisis de caso en el sur de la Patagonia. Desde el País de los Gigantes. Perspectivas Arqueológicas en Patagonia (pp. 283–296) Río Gallegos: UNPA.

Goñi R., Belardi, J., Espinosa, S., & Savanti, F. (2004). Más vale tarde que nunca: Cronología de las ocupaciones cazadoras recolectoras en la cuenca del lago Cardiel (Santa Cruz, Argentina). In T. Civalero, P. Fernández, & G. Guráieb (Eds.), Contra viento y marea. Arqueología de Patagonia (pp. 237–248). Buenos Aires: INAPL-SAA.

Goñi, R., Belardi, J., Re, A., Nuevo Delaunay, A., Molinari, R., & Ferraro, L. (2007). Los grabados de la meseta del lago Strobel (Patagonia Argentina) desde una perspectiva regional. Actas del Primer Simposio Nacional de Arte Rupestre (Cusco, noviembre de 2004). Actes & Memoires de l´Ínstitut Francais d´Etudes Andines, 12, 427–438.

Goñi, R., Belardi, J., Cassiodoro, G., Rindel, D., García Guraieb, S., & Bourlot, T. (2014). Registro arqueológico y cronología de las ocupaciones cazadoras recolectoras en la cuenca del lago Cardiel. In R. Goñi, J. Belardi, G. Cassiodoro, & A. Re. (Eds.), Arqueología de las Cuencas de los Lagos Cardiel y Strobel. Poblamiento Humano y Paleoambientes en Patagonia (pp. 41–66). Buenos Aires: Aspha Ediciones.

Goñi, R., Cassiodoro, G., Re, A., Guichón, F., Flores Coni, J., & Dellepiane, J. (2010). Arqueología de la meseta del lago Guitarra (Santa Cruz). In R. Bárcena & H. Chiavazza (Eds.), Arqueología Argentina en el Bicentenario de la Revolución de Mayo, XVII Congreso Nacional de Arqueología Argentina (pp. 1923–1928). Mendoza: UNCuyo-CONICET.

Goñi, R., Espinosa, S., Belardi, J., Molinari, R., Savanti, F., Aragone, A., Cassiodoro, G., Lublin, G., & Rindel, D. (2005). Poblamiento de la estepa patagónica: Cuenca de los lagos Cardiel y Strobel. Actas del XIII Congreso Nacional de Arqueología Argentina, 7–18.

Gradin, C., Aschero C., & Aguerre, A. (1976). Investigaciones arqueológicas en la Cueva de las Manos, Estancia Alto Río Pinturas, Pcia. de Santa Cruz. Relaciones de la Sociedad Argentina de Antropología, 10, 201–270.

Guráieb, G. (1998). Cuáles, cuánto y de dónde: Tendencias temporales de selección de recursos líticos en Cerro de los Indios I (Lago Posadas, Santa Cruz). Arqueología, 8, 77–99.

Hermo, D. (2009). Estructura de los recursos líticos y paisajes arqueológicos en el Nesocratón del Deseado (Santa Cruz, Argentina). Arqueología Suramericana, 5, 178–203.

Jones, G., Beck, C., Jones, E., & Hughes, R. (2003). Lithic source use and paleoarchaic foraging territories in the Great Basin. American Antiquity, 68, 5–38.

Knell, E., & Hill, M. (2012). Linking bones and stones: Regional variation in Late Paleoindian Cody Complex land use and foraging strategies. American Antiquity, 77(1), 40–70.

Limpert, E., Stahel, W.A., & Abbt, M. (2001). Log-normal distributions across the sciences: Keys and clues. Bioscience, 51(5), 341–352.

Luedtke, B. (1979). The identification of sources of chert artifacts. American Antiquity, 44, 744–757

Lyons, W.H., Glascock M.D., & Mehringer, P.J., Jr. (2003). Silica from sources to site: Ultraviolet fluorescence and trace elements identify cherts from Lost Dune, southeastern Oregon, USA. Journal of Archaeological Science, 30, 1139–1159.

Molinari, R., & Espinosa, S. (1999). Brilla tu, diamante "loco." Soplando en el Viento. Actas de las III Jornadas de Arqueología de la Patagonia (pp. 189–198). Neuquén: INAPL-UN de Comahue.

Nami, H. (1992). El subsistema tecnológico de la confección de instrumentos líticos y la explotación de los recursos del ambiente: Una nueva vía de aproximación. Shincal, 2, 33–53.

Nash, D.J., Coulson, S., Staurset, S., Smith, M.P., & Ullyot, J.S. (2013a). Provenancing silcrete in the Cape coastal zone: Implications for Middle Stone Age research in South Africa. Journal of Human Evolution, 65, 682–688.

Nash, D.J., Coulson, S., Staurset, S., Ullyott, J.S., Babutsui, M., Hopkinson, L., & Smith, M.P. (2013b). Provenancing of silcrete raw materials indicates long-distance transport to Tsodilo Hills, Botswana, during the Middle Stone Age. Journal of Human Evolution, 64, 280–288.

Nazaroff, A.J., Baysal, A., & Çiftçi, Y. (2013). The importance of chert in Central Anatolia: Lessons from the Neolithic Assemblage at Çatalhöyük, Turkey. Geoarchaeology, 28, 340–362.

Neff, H. (2000). Neutron activation analysis for provenance determination in archaeology. In E. Ciliberto, & G. Spoto (Eds.), Modern analytical methods in art and archaeology (pp. 81–134). New York: John Wiley & Sons.

Odling-Smee, F., Laland, K., & Feldman, M. (2003). Niche Construction. The neglected process in evolution. Monographs in Population Biology, 37.

Parish, R.M., Swihart, G.H., & Li, Y.S. (2013). Evaluating Fourier transform infrared spectroscopy as a non-destructive chert sourcing technique. Geoarchaeology, 28, 289–307.

Paunero, R., Cueto, M., Frank, A., Ghidini, G., Rosales, G., & Skarbun, F. (2004). Comunicación sobre campaña arqueológica 2002 en localidad la María, Santa Cruz. In T. Civalero, P. Fernández, & y G. Guráieb (Eds.), Contra viento y marea. Arqueología de Patagonia (pp. 797–808). Buenos Aires: INAPL-SAA.

Ramos, V. (1982). Geología de la región del lago Cardiel (Provincia de Santa Cruz). Revista de la Asociación Geológica Argentina, 37, 23–49.

Re, A., Guichon, F., & Belardi, J. (2013). Las mesetas de San Adolfo y del Cardiel Chico (provincia de Santa Cruz): Su uso y jerarquización regional a partir de los motivos rupestres. Unpublished manuscript. Cuadernos del Instituto Nacional de Antropología y Pensamiento Latinoamericano, Buenos Aires.

Renfrew, C. (1977) Alternative models for exchange and spatial distribution. In T. Earle, & J. Ericson (Eds.), Exchange systems in prehistory (pp. 71–90). New York: Academic Press.

Rindel, D., Bourlot, T., Martínez, C., Rapela, I., & Pasqualini, S. (2010). Prospecciones arqueológicas en sitios a cielo abierto y aleros del noroeste del lago Cardiel: Primeros resultados. In R. Bárcena, & H. Chiavazza (Eds.), Arqueología Argentina en el Bicentenario de la Revolución de Mayo, XVII Congreso Nacional de Arqueología Argentina (pp. 1969–1973). Mendoza: UNCuyo-CONICET.

Sayre, E.V. (1975). Brookhaven procedures for statistical analyses of multivariate archaeometric data. Brookhaven National Laboratory Report, BNL-21693.

Stern, C. (2004). Obsidian in southern Patagonia: Review of the current information. In T. Civalero, P. Fernández, & G. Guráieb (Eds.), Contra viento y marea. Arqueología de Patagonia (pp. 168–176). Buenos Aires: INAPL-SAA.

Stern, C., Gómez Otero, J., & Belardi, J. (2000). Características químicas, fuentes potenciales y distribución de diferentes tipos de obsidianas en el norte de la provincia de Chubut, Patagonia Argentina. Anales del Instituto de la Patagonia, 30, 167–174.

Stern, C., Mena, F., Aschero, C., & Goñi, R. (1995). Obsidiana negra de los sitios arqueológicos en la precordillera andina de Patagonia central. Anales del Instituto de la Patagonia, 23, 111–118.

Stine, S., & Stine, M. (1990). A record from Lake Cardiel of climate change in southern South America. Nature, 345, 705–708.

Ward, J. (1983). Hierrarhical grouping to optimize an objective function. Journal of American Statistica Association, 48, 236–244.

Wilson, L. (2007). Understanding prehistoric lithic raw material selection: Application of gravity model. Journal of Archaeological Method and Theory, 14, 388–411.

